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Recent Changes at Western Electric Power Plant

FACTORY PLANT INCREASES CAPACITY AND RELIABILITY BY INSTALLING TURBINES AND COMPLETE COAL AND ASH HANDLING EQUIPMENT

IN RECENT YEARS the power plant of the Western Electric Co., at Hawthorne, Ill., has undergone a number of important changes which have increased its capacity, reliability and efficiency. At no time could this plant be considered behind the times, but an increasing load, recent development in power plant machinery, together with modern methods of operating power plants have placed it in a class somewhat different from that for which it was originally designed.

It is the new features of this plant, together with some of the operating data, particularly of the boiler room, that we wish to present to our readers at this time.

COAL AND ASH HANDLING

AN INCREASING power load, combined with changes in furnace construction making possible increased generation of steam, put the power plant in a position where the coal bunkers over the boilers were not sufficiently large in capacity to insure the plant against delays in coal deliveries. This and the former inconvenient

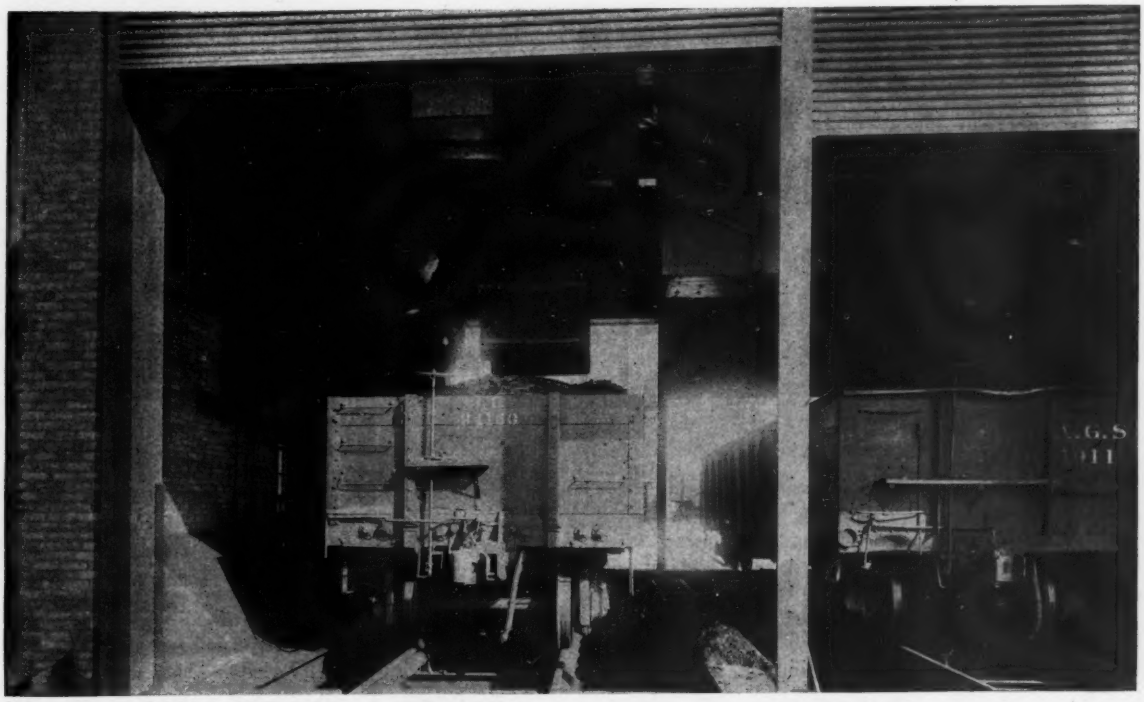


FIG. 1. VIEW OF COAL UNLOADING EQUIPMENT SHOWING TRAVELING CRANE WITH GRAB BUCKET AND ASH CHUTES ALSO INCLINED TRACK TO RECEIVING HOPPERS

method of handling the ash caused the management to install a complete coal and ash handling system which has now been in service about one year.

The complete system is the product of the Link-Belt Co. and consists of 2 24 by 30 Peck pivoted bucket overlapping carriers, each being 272½ ft. long with an elevation of 60 ft. A 20-hp. motor drives each conveyor and is located at the head of the descending side of the conveyor. The normal capacity of each conveyor is 75 tons per hour, traveling at 45 ft. a min., and the whole system is operated by 3 men, who work during one 10-hr. shift. In winter the coal consumption runs about 260 tons a day, but in summer it is reduced to 150 to 175 tons.

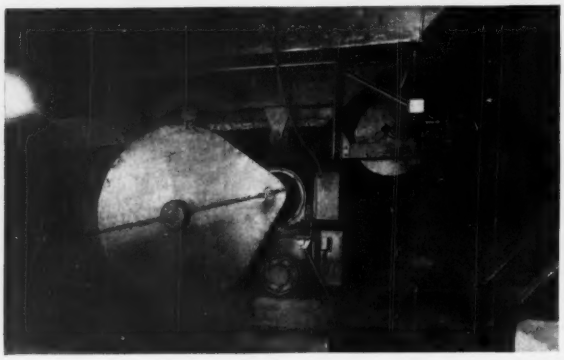


FIG. 2. COAL CRUSHER BENEATH RECEIVING HOPPER

One of the practical features of this installation is the receiving building, which is located about 70 ft. from the end of the main boiler room, to which it is connected by means of underground tunnel and overhead bridge.

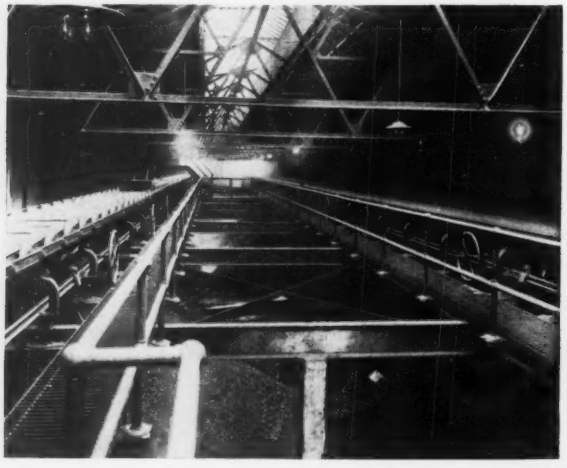


FIG. 4. VIEW OF COAL BUNKERS OVER BOILERS

This arrangement permitted the installation of very large track hoppers with ample track room, and most modern provision for dumping and unloading the coal. This arrangement also gives a large ash bin capable of holding several car loads of ashes. They have avoided the common mistake of cramping themselves at this point.

Coal is delivered to the plant daily, preferably in drop bottom cars, although a traveling grab bucket is provided for unloading from cars with flat bottoms. The order to the coal dealer varies from 4 to 7 cars a day. These come to the plant on 2 elevated railroad tracks, which are slightly inclined so that the loaded cars run by gravity to the track hoppers; over these the tracks are level, but are again inclined to take the unloaded cars away on the other side of the hoppers.

FIG. 3. CHUTES TO CONVEYOR FOR RECLAIMED COAL AND ASH

Under the tracks at the receiving end of the system are 2 hoppers, from which reciprocating feeder conveyors operated by 5-hp. motors deliver the coal either to the crushers or direct to the conveyors. Coal delivered to these is elevated and carried overhead to the boiler room bunkers and dumped by automatic trippers at any desired point. The capacity of the bunkers is now 1200 tons, which gives some margin to work upon in case of delay in deliveries.

FIG. 5. LOCOMOTIVE GRAB BUCKET CRANE AT COAL STORAGE PIT

At present 1½-in. Illinois screenings are used, but in case a delivery of run-of-mine should be received, provision is made for taking care of it by running it

through crushers on its way from the receiving hoppers to the conveyors. The 2 crushers are each 28 by 30 in. of the 2-roll type, mounted on steel supports and carried on rollers, so that the crushers can be moved from under the feeders when fine coal is received. These crushers are driven by 20-hp. motors.

Ashes discharged over the end of the chain grate stokers fall into pits which empty through chutes direct to the conveyor buckets and are elevated and stored in a bin over the tracks and coal receiving hoppers. Ash cars are loaded by gravity from this bin or ashes may be discharged through a chute at the side into wagons for local delivery.

Fine coal and coke which drop through the front of the grates are caught in hopper shaped pits and delivered to the conveyor, similarly to the ashes, and carried back to the bunkers over the boilers.

Coal is weighed as it comes to the plant, but is not weighed as it is fed to the stokers, so that average results only are secured and reported monthly. Tests, however, are run occasionally at which time both water and coal are weighed.

With the grade of coal used best results are secured by giving it a good wetting before firing in this furnace. When this is not done considerable unburned coal goes through the grates and it is difficult to secure complete combustion as the fuel bed becomes uneven, the draft being clogged in spots. Wetting does away with these troubles, aids coking and helps in the prevention of clinker formation.

An interesting feature in connection with the coal handling facilities of this plant is a storage pit where coal is kept under water. After thorough investigation of losses occurring during storage and danger due to spontaneous combustion the company built the pit substantially as indicated in the drawing, Fig. 7. It is made of concrete, and rain water from adjoining buildings keeps the coal submerged. As will be noted, the pit has over it at frequent intervals railroad tracks, from which a locomotive grab bucket is used to load cars as required.

Coal is delivered here for storage, and is taken out only when regular deliveries to the plant are interrupted for any cause whatever.

Steam Generation

In the main boiler room are 10 Aultman & Taylor water-tube boilers rated at 500-hp. each. In other parts of the factory are 4 boilers used as crematories for burning waste materials and rubbage.

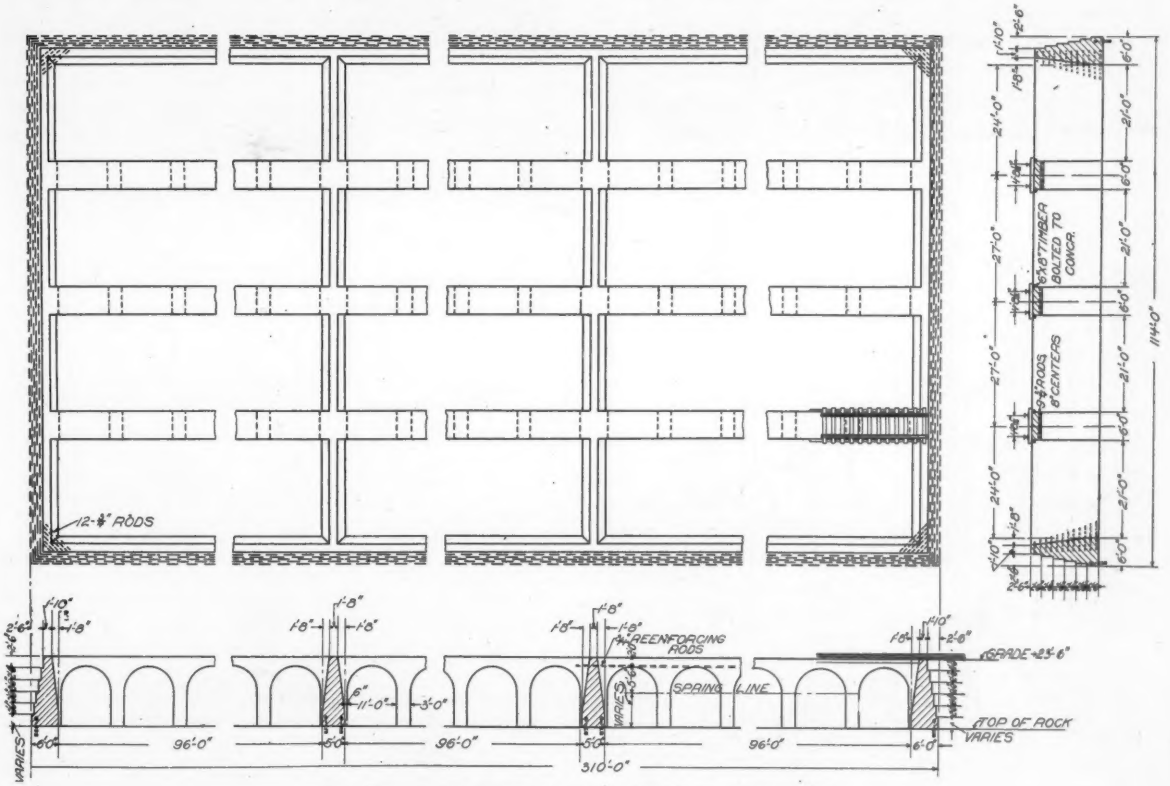


FIG. 7. PLAN AND ELEVATIONS OF COAL STORAGE PIT

Originally the main boilers had vertical baffles, but it was found difficult to force the boilers with this arrangement without making an objectionable amount of smoke, so the baffling was changed to that shown in the sketch, Fig. 8, C tile being used on the lower row of water tubes. The boilers are now operated at 800-hp. continuously as is indicated by steam flow meters.

Another change made in the boiler setting was the installation of a water back in the bridge wall which is the design of the engineer in charge. Three ordinary boiler tubes attached to special fittings at the ends support the overhung part of the bridge wall. The fittings are provided with handhole plates which allow the tubes to be cleaned with a turbine cleaner. The arrangement has

the effect of a 3-pipe coil over the rear end of the grate and has been in service 4 yr. without giving any trouble. The rear tube is connected to the bottom of the back header by a sweeping bend and the front tube is connected in a similar manner to the front of the steam drum and good circulation is thus secured.

Load conditions in the plant are very steady, the only fluctuations being in the amount of heat required to keep the buildings comfortable. It is the ordinary practice to have one of the 10 boilers out of service for cleaning, inspection and repairs; the other 9 boilers are kept in service or banked to give the desired load of 800-hp. on boilers in operation. The 4 boilers used for

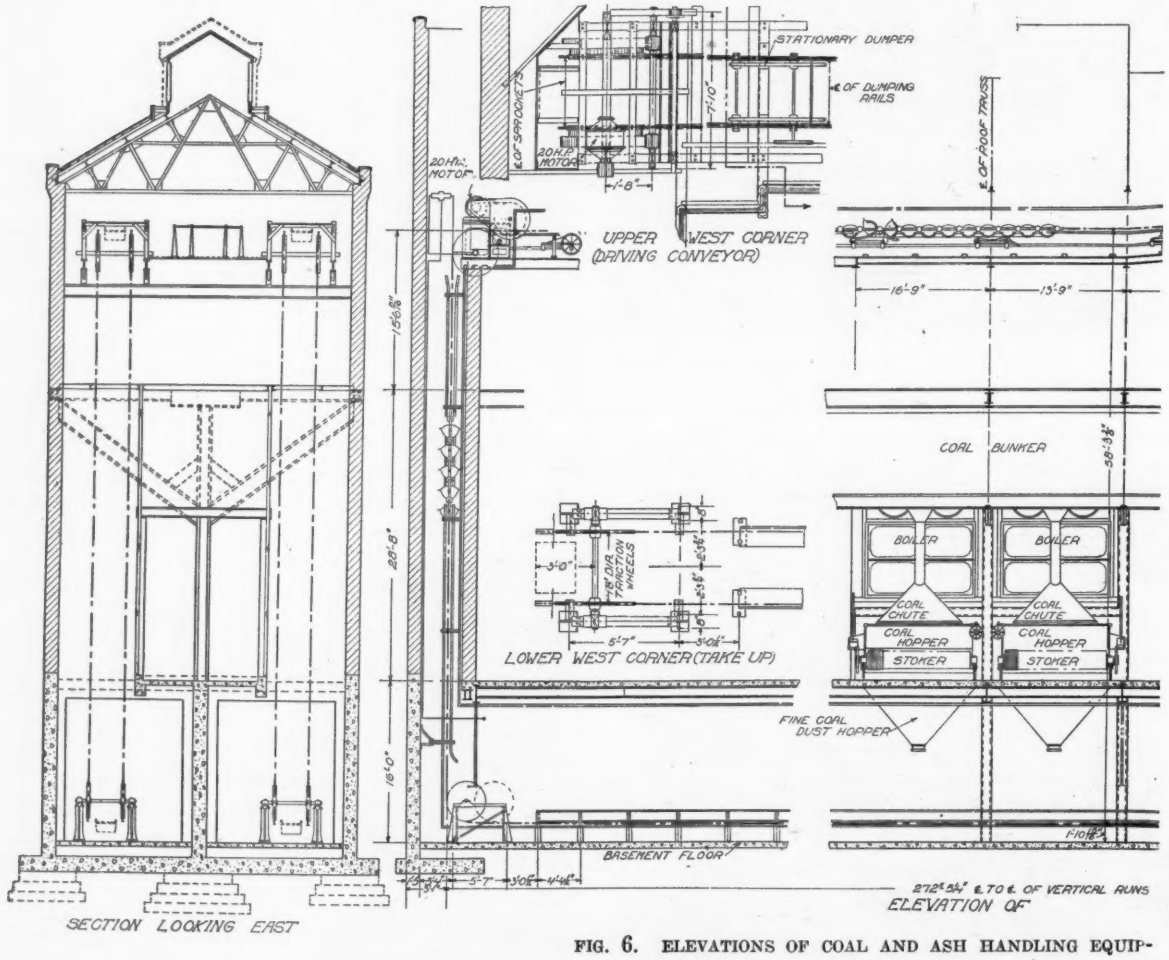


FIG. 6. ELEVATIONS OF COAL AND ASH HANDLING EQUIP-

burning waste are connected to the same steam piping and work at such a rate as to keep the waste burned up.

Boilers in the main plant are arranged 8 on one side of the aisle and 2 on the other, leaving room for 6 more boilers to be installed when load requirements demand. Each of the boilers is served by a Green chain grate with an effective area 10½ ft. by 12 ft. or 126 sq. ft. Before the change in baffling, however, the grate area was only 77 sq. ft.

Tubes in the boilers are arranged 14 high and 18 wide, and are connected through headers to 2 drums, each 42 in. by 23 ft. 3⅝ in. Foster superheaters are placed above the first pass and are designed to give 100 deg. superheat. The boilers are designed to carry 200 lb. steam pressure, but are worked at 150 lb.

Stokers are operated from an overhead shaft which is run by belt from a vertical engine. The speed of this engine is under the direct control of the McDonough damper regulator, but the grate speeds are adjusted individually, as there is some difference in the available draft for the different boilers. The average grate speed is about 6 in. a minute and the thickness of the fuel bed is between 5½ and 6 in.

The plant is served by 2 stacks, each being 250 ft. high and 12 ft. inside diameter. Two Green fuel economizers are installed to take gas from 8 boilers; each of these consists of 68 sections of 12 tubes 4.9 in. external diameter by 12 ft. long. The total heating surface of each economizer is 10,850 sq. ft.

At the base of the stack the draft is measured by a recording gage and runs about 1¼ in. of water; at the entrance to the economizer the draft is 1 in., at the breeching damper 0.8 in., and over the fire 0.25 in. The stack temperature is about 350 deg. F.

At present a series of tests is being conducted to determine the percentage of CO_2 in the flue gases which should be maintained for best results. For this purpose a form is made up to record readings and gases are analyzed at frequent intervals during the day with an

Orsat instrument which is connected up as indicated in the sketch, Fig. 9. Only one boiler is tested at a time, but the instrument is changed each day from one boiler to another. With the connections employed no gas collector is needed, and the readings being immediate are an aid to the firemen in maintaining proper furnace conditions.

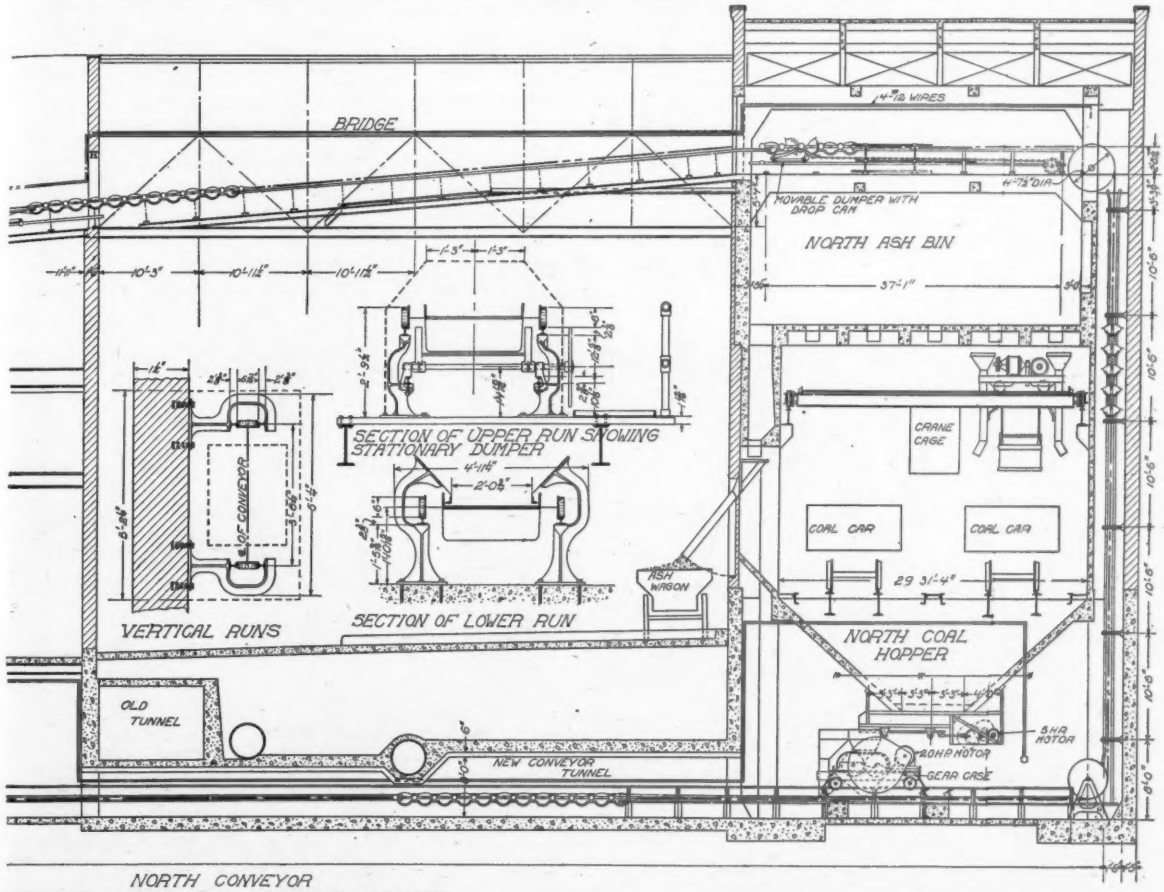
Another check on combustion which has recently been inaugurated is the systematic determination of combustible in ashes. Each day samples are taken from the different boilers and after drying and quartering they are weighed and burned until no more combustible remains, then weighed and the percentage of combustible in the ash calculated.

Feed water comes principally from the city mains, but is also made up of condensate returns from the plant piping and heating system. All of this goes to an 8000-hp. Cochrane open feed water heater. No water treatment is employed, and the water, heated to a temperature of about 190 deg. F., is pumped through Venturi meters and the economizers to the boilers, having been raised in the economizers to a temperature of 240 deg. F.

Steam for the feed-water heater is the exhaust from the auxiliaries consisting of boiler feed pumps, air compressors, exciter turbines, condenser turbines, oil pumps, etc. The heater is maintained at or below atmospheric pressure, but when the exhaust from the auxiliaries is more than needed in the heater an automatic hydraulic valve operates to allow the surplus to go over to the heating system.

Feed water level in the boilers in under the control of S. C. feed water regulators of the continuous flow type and for safety, low water alarms are installed. On each boiler are 3 4-in. pop safety valves, one of which is attached to the superheated steam piping and set to blow at 158 lb.; the other two are connected to a cross over between the drums and blow at 160 lb.; the blow back is adjusted for 3 lb.

Steam is carried to the main header in the boiler room through long radius vertical bends. In each lead is the regular by-passed gate valve at the header and in addition an automatic non-return stop valve.



NORTH CONVEYOR
MENT WITH DETAILS OF CONVEYOR SUPPORTS

Changes in Generating Equipment

To take advantage of the economy in space and higher efficiency offered by turbines of recent design, part of the old reciprocating generating equipment has been replaced by turbines and the reciprocating units which still remain will be replaced as necessity for greater capacity demands.

The generating equipment which has been replaced consisted of 3, 300-kw. and 1, 500-kw. generators, direct connected to horizontal cross-compound, condensing engines. These units furnished direct current at 230 v.

To take their places 4 turbines and 2 rotary converters have been installed; these are 1 2000-kw., 4-stage,

2 3000-kw., 9-stage, and 1 750-kw., 5-stage Curtis turbines of the horizontal type, all run at 1800 r.p.m. and furnish 60-cycle, 3-phase current at 460 volts. The 4-wire star system of distribution is employed.

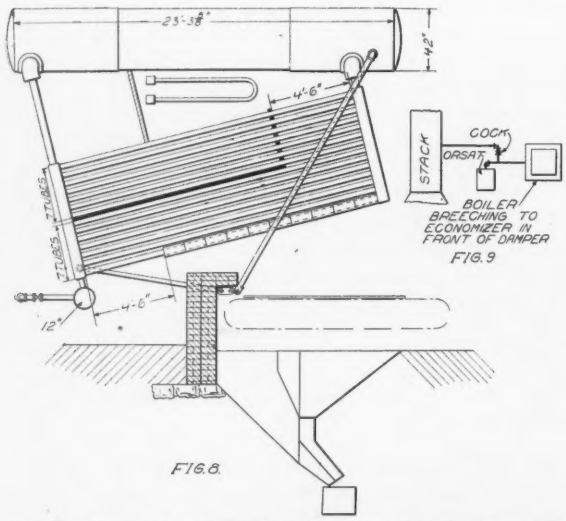


FIG. 8. DIAGRAM OF BOILER BAFFLING AND WATER BACK
FIG. 9. DIAGRAM OF CONNECTIONS FOR TAKING FLUE GAS SAMPLES

Cooling water for the condensers is taken from a pond with a capacity of 5,000,000 gal. into which the heated water is sprayed through a system of Schutte & Koerting nozzles. This maintains a cooling water temperature in the summer within 5 or 10 deg. of the atmosphere and in winter the condensing water used is never below 40 deg. The rise in temperature through the condensers is 10 deg.

The direct current now used about the factory is furnished by 2 500-kw. rotary converters with the reciprocating units still in the plant as standby generators. The latter consists of one 1000-kw. d.c. Western Electric generator direct connected to a vertical Filer & Stowell cross-compound, condensing engine and one 1200-kw. generator connected to a Rice & Sargeant vertical cross-compound, condensing engine.

Excitation for the turbines is furnished by 2 turbine-driven 75-kw., d.c. generators run at 3300 r.p.m. and furnishing current at 125 volts.

One of the attractive features of the plant is the main switchboard which is a model of convenience and beauty. It consists of a regulator panel, an exciter panel, a panel for each generator, 2 panels for each rotary converter, 6 d.c. distributing panels and 12 a.c. distributing panels with remote control switches for the current breakers beneath. On the a.c. distributing panels there

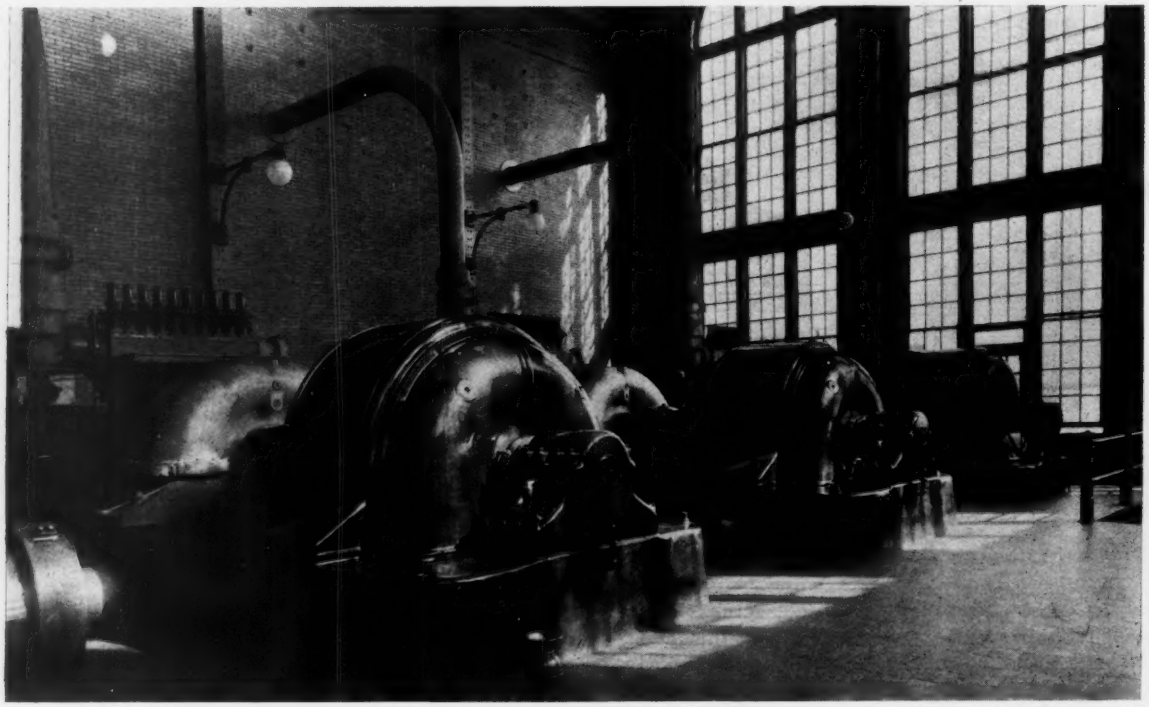


FIG. 10. MAIN GENERATING TURBINES OF WESTERN ELECTRIC CO. PLANT

These are all served by Alberger jet condensers located directly under the turbines. In the winter time, however, one of the 3000-kw. and the 750-kw. turbines exhaust into the heating system, the pressure here being about atmospheric while that maintained by the condenser averages 28 in. vacuum.

is an ammeter for each circuit also an integrating wattmeter and for each 2 circuits an indicating wattmeter is provided.

Heating System

Among changes of importance made in the plant during recent years is the heating system. Formerly the

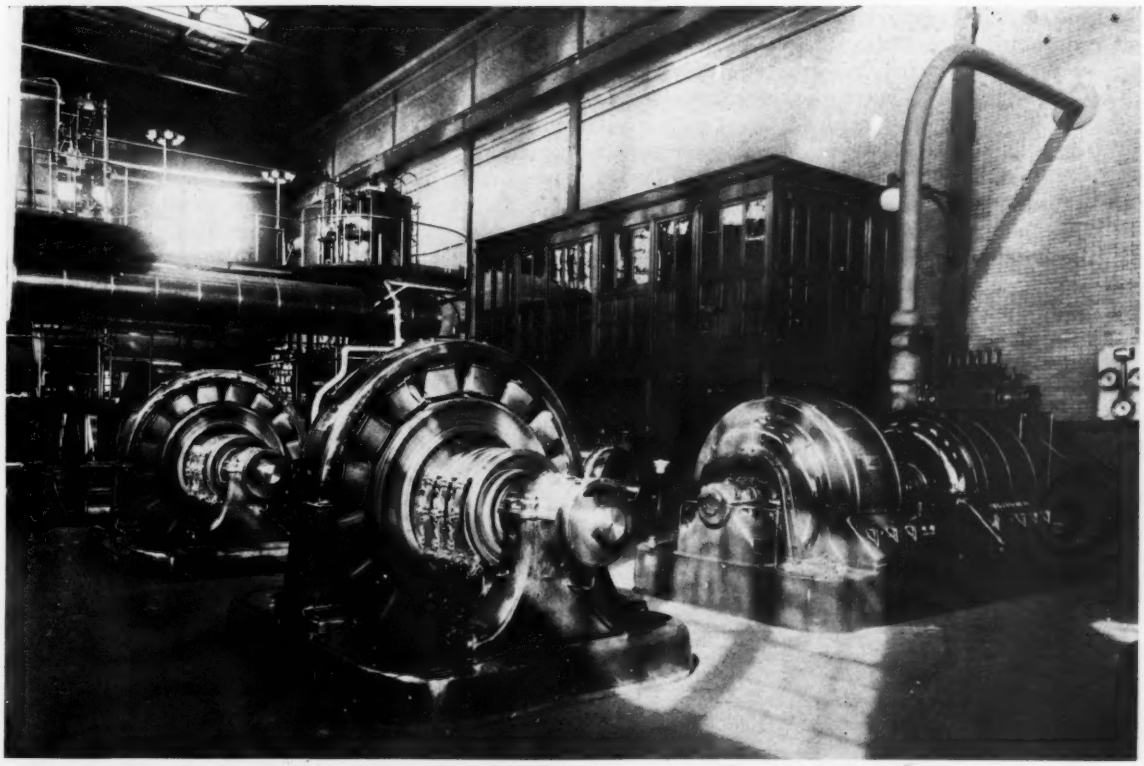


FIG. 11. VIEW IN GENERATING ROOM SHOWING VERTICAL RECIPROCATING UNITS IN BACKGROUND WITH ROTARY CONVERTERS AND SMALL TURBINE IN FRONT

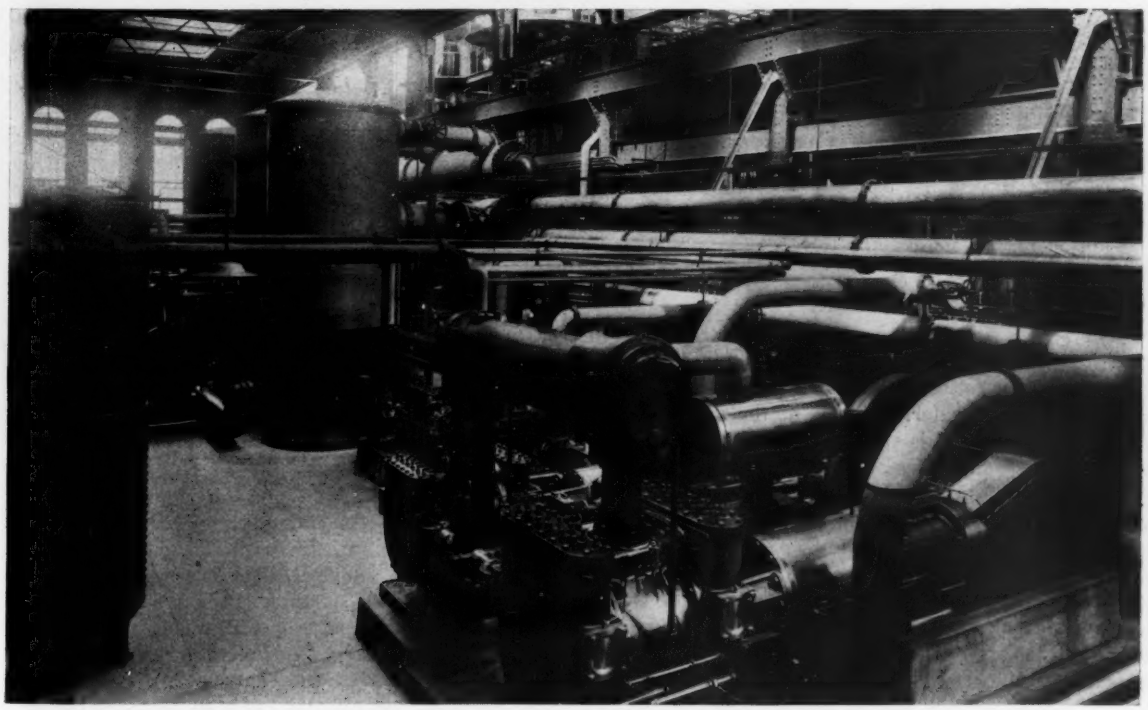


FIG. 12. WATER HEATERS FOR HEATING SYSTEM WITH LOW PRESSURE AIR COMPRESSORS IN FOREGROUND

entire factory was heated by exhaust steam transmitted from the power plant and this method is still employed in some of the buildings, but the great share of heating is now done with hot water, the source of the heat being, as previously stated, the exhaust from 2 of the turbines supplemented by surplus exhaust from the auxiliaries and live steam when needed.

Water is heated in 3 1400-hp. closed type heaters, each having a heating surface of 5780 sq. ft. The exhaust steam pressure on these heaters varies from 6 in. vacuum to atmospheric, and each heater has a live steam connection but one is designed to carry high pressure steam when for any reason it is found necessary.

turbine at 1600 r.p.m. The pump takes its suction from the buildings and forces the water up through the heaters and out through the circuit.

Among the side issues of this plant are: a drinking water filtering and cooling system requiring an 80-ton Frick compressor; a high-pressure air compressor furnishing air at 1000 lb. for a compressed air locomotive operating in a lumber yard; 2 low-pressure air compressors furnishing air at 90 lb. for factory and blowing purposes; and 2 hydraulic elevator pumps which furnish water at 800 lb. pressure for 8 elevators.

Throughout the entire plant instruments and appliances which make for higher efficiency are employed, and

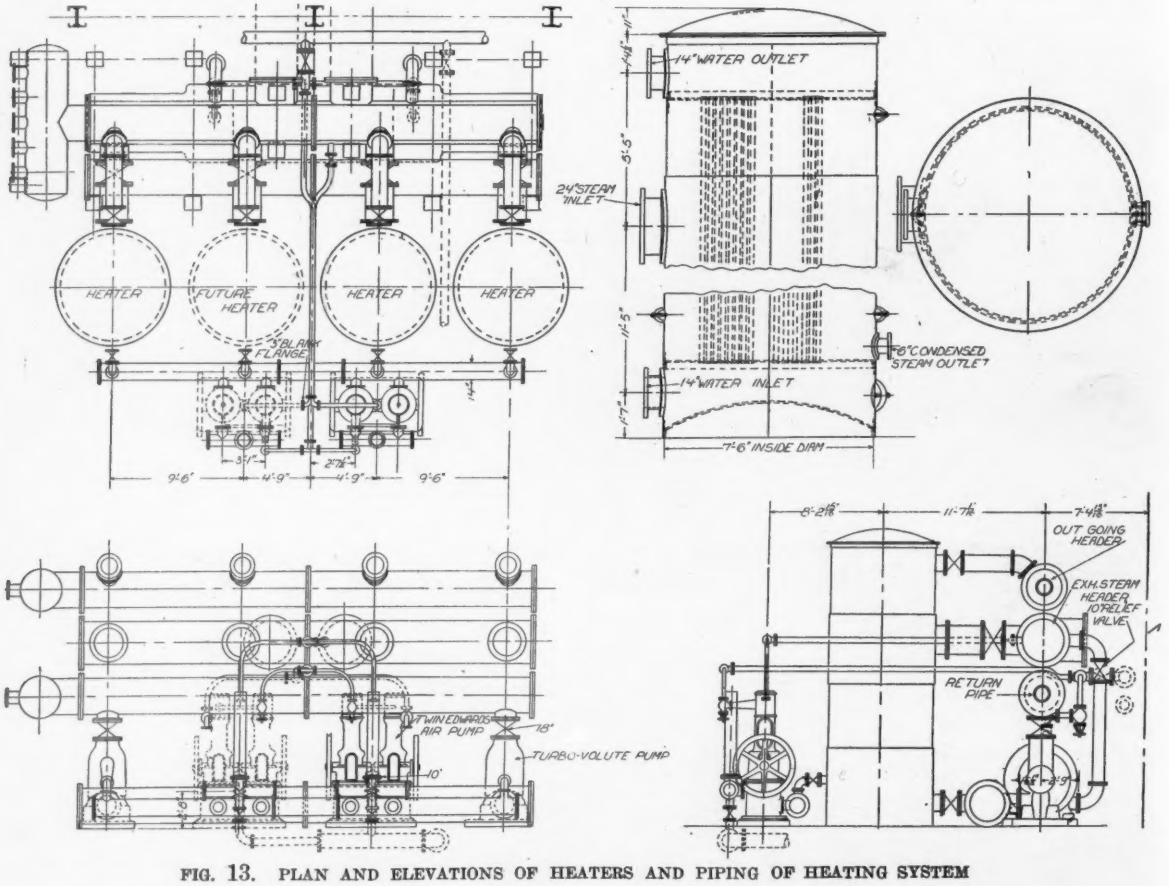


FIG. 13. PLAN AND ELEVATIONS OF HEATERS AND PIPING OF HEATING SYSTEM

Condensate is returned by a Wheeler-Edwards pump to the feed water heater. This is of the vertical type, 8 by 20 by 12 in., and is shown in Fig. 12 connected to the heaters.

The total radiating surface supplied by these heaters is 285,710 sq. ft., and the farthest point of transmission from the plant is 1500 ft. The transmission piping in the tunnels is insulated with hair felt and consists of 1, 12-in., 2, 10-in., and 2, 9-in., outgoing and a like number and size of return pipes. During weather requiring atmospheric pressure on the heaters the outgoing water has a temperature of about 185 deg., while the temperature of returns is 15 to 20 deg. lower.

This water is circulated by a 16-in. Alberger double suction volute pump driven by a direct connected Curtis

the plant presents a good example of how an existing large and growing factory plant may be kept modern in equipment and operation.

REMOTE-CONTROL light and fog-signal stations, consisting of 500-watt incandescent lamps in lens lanterns and electric sirens, are in successful operation at Point Blunt and Point Stuart, Angel Island, Cal. The controlling station is located about one mile from Point Stuart and 2 mi. from Point Blunt. An arrangement of magneto relays in conjunction with a telephone enables the keeper at the control station to open and close the siren circuit and to listen to the operation of the fog signal through the medium of a single wire.—Electrical Review and Western Electrical.

An Interesting Mines Power System

CHAIN OF HYDROELECTRIC AND STEAM PLANTS REDUCES MINING COSTS. BY L. R. W. ALLISON

THE Arkansas Valley Railway, Light & Power Co., operating in the gold and coal mining districts of Pueblo, Colorado, and vicinity, has installed an extensive and interesting electric power system, serving about 25 municipalities devoted to mining operations, with a total population of about 100,000.

Near Victor, a main hydroelectric power station, shown in Fig. 1, has been located on Beaver Creek, in a mountainous country offering many difficulties in connection with initial construction work. This plant, known as the Skaguay Power Station, operates under a head of about 1160 ft., water being furnished by a pipe line from a storage reservoir of 140 acres, formed by a dam 400 ft. long and 83 ft. high.

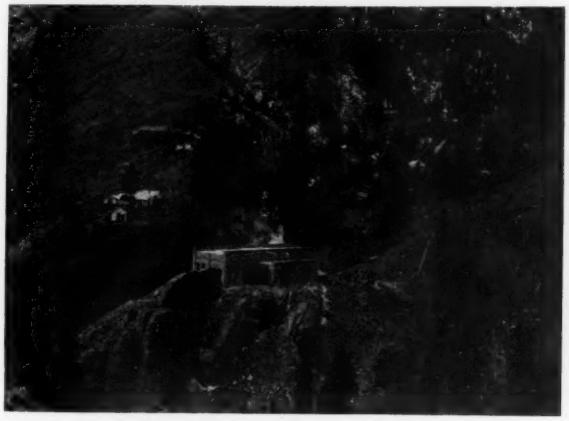


FIG. 1. HYDROELECTRIC STATION ON BEAVER CREEK NEAR VICTOR, COLO.

This plant has a generating capacity of 1300 kw., and is connected to a duplicate circuit, 25,000-v. transmission system, 42 mi. long, reaching from Victor to Pueblo. The hydroelectric station is supplemented at the latter place by a steam generating plant with a capacity of 5300 kw. A second steam operated plant is located at Canon City, which with a generating installation of 4700 kw. affords a total capacity for the system of 11,300 kw., or about 15,000 hp.

Indicated in Fig. 2 is the transmission system, which comprises a total of 170 miles of 25,000-v. lines, a secondary system of 70 mi. operating under 13,000 v., and about 200 mi. of local distributing lines in the various localities. The city of Pueblo is located in the center of this system, which embraces a territory extending from Cripple Creek on the northwest to La Junta on the southeast, with a loop reaching from Victor to Canon City and thence to a connection with the main 25,000-v. lines. The high tension system is tied in so as to allow concordant operation of the 3 power stations to furnish electric energy to the lines at one time.

For effective operation, the territory served is handled in the 3 divisions, known as the Pueblo division, the Mountain division and the Valley division. The first includes the supplying of electric light and power, as well as the operation of the street railway system, at Pueblo and outlying districts. The second division takes in Canon City, Victor, Cripple Creek, Goldfield and immediate vicinity; and the third, or Valley division, comprises La Junta, Fowler, Ordway and surrounding neighborhood. The load dispatcher is stationed at Canon City, with the entire high tension system under his supervision and control.

The annual output of these divisions comprises a total of about 45,000,000 kw.-hr., the Pueblo and Valley divisions aggregating 14,500,000 and the Mountain division 30,500,000.

In the Cripple Creek district, electric energy is distributed for mining operations at 500 and 6000 v., 3-phase, 30-cycle, alternating current. In this section, the company has a connected load of about 9000 hp. for the operation of ore reduction mills, electric hoists, compressors, drills and kindred equipment. The larger mining properties have individual substations, taking electric energy direct from the high potential lines and reducing to the necessary operating voltage.

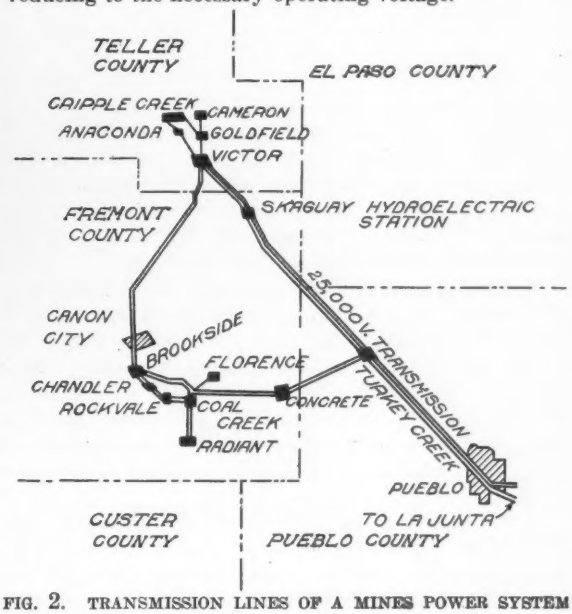


FIG. 2. TRANSMISSION LINES OF A MINES POWER SYSTEM

The cost of ore-crushing in this district varies from 5 to 10 cents a ton, cheaper than any other locality similarly situated. This is due to the extensive power made available by the company's lines and a low initial cost for service; many mining properties have been opened up and operation perfected which would not otherwise be profitable. This effective mines power system is operated under the general direction of W. F. Raber, to whom the writer is indebted for information noted in this article.

U. S. A. EQUIPMENT is to be used in an electric light plant for Puerto Colombia for which surveys and plans are now under way. The Colombian Congress has appropriated $5000 for the purpose, and lights will be supplied for the village, railway and pier, also one 2000-c.p. search light and 2 of 1000 c.p. each for use by the coast guard in policing the bay.

Memory Classification of Storeroom Material

By Wilfred G. Astle

MUCH thought has been given the matter of proper classification of storeroom material by prominent engineers and many of them have favored a numerical system for this purpose. The one thing in favor of the numerical system is that it can be readily applied, but after it has once been worked up and put into force it soon becomes unwieldy due to its inflexibility, and then trouble starts. The memory or mnemonic system on the other hand requires considerable work and time to make up and apply, but its flexibility and ease in memorizing after once installed cannot help but appeal to all concerned.

Another practice which is frequently used is that in which figures are used in conjunction with letters, such figures being placed before the fourth letter of the symbol indicating an arbitrary subdivision of that letter. While there may be some good points in favor of this practice, it seems that, having started out with the idea of a memory symbolization, it would be better to utilize it throughout and only turn to figures as a last resort where an arbitrary classification is an absolute necessity. Figures should only be used to indicate standard sizes carried in stock, thus eliminating the necessity of writing out the entire size figures. Another point in favor of using the memory method in subdivision as well as main classes and using such letters as affixes to the last letter of the class to be subdivided, is that it does not throw out of position the general symbol.

A good symbol system requires to be complete, simple, flexible, uniform, and conform to all other symbol systems in the plant; therefore, it is most essential that all the general classifications should be worked out in advance. The classification must be, as far as possible, an aid to memory by representing the initial, secondary, or most prominent letter of the article represented. It must enable convenient location of material in the storeroom by order of symbols.

The first letter in all symbols representing storeroom material should be S, signifying Stores, and if the classification is properly worked out on the start, this letter as the initial letter of a symbol will be omitted from all other classifications. This will enable anyone to know that when a symbol begins with S that it indicates storeroom material only.

The second letter should be the initial letter of the name or the purpose for which the material is used, to cover material used exclusively for that article or purpose, as for example:

SA—Stores Used for Automobiles.
SO—Stores Used for Overhead Construction.
SS—Stores Used for Steam Generating Plant.
SU—Stores Used for Underground Construction.

There is much more material in most storerooms which is used for a variety of purposes than is used for certain specific purposes only, and such material is indexed under V—SV meaning that the material is used for a variety of purposes.

The third letter should signify the nature of the material and usually the same letters in the third position will be used regardless of whether the second letter is V or one of the others, indicating the general purposes. For example, SAC would signify Castings for Automobile Repairs in Stores, while SVC would signify Castings for Various Purposes in Stores.

The third division list for SV would read:

SV—Stores for Various Purposes.
SVA—Abrasives.
SVB—Bars.
SVC—Castings and Forgings.
SVE—Electrical Material.
SVF—Fastenings.
SVG—Gages, Gage Glasses.
SVH—Lumber.
SVK—Miscellaneous Metals.
SVL—Liquids.
SVM—Lump Material.
SVN—Oil Cups, etc.
SVP—Powders, Etc.
SVR—Greases, Pastes, etc.
SVS—Sheets.
SVT—Tools, etc.
SVV—Plates.
SVW—Wire.
SVX—Shop Fixtures.
SVY—Yardage.
SVZ—Miscellaneous.

The fourth letter of a memory symbol should be the general subdivisions of the 3 letter symbol, as for example, under SVB, Bars, would be given:

SVBA—Structural Shapes.
SVBB—Brass Bars.
SVBC—Copper Bars.
SVBD—Drill Rod.
SVBF—Fibre Bars.
SVBM—Machinery Steel.
SVBP—Pipe, Tubing, etc.
SVBR—Cold Rolled Steel.
SVBS—Solder.
SVBT—Tool Steel.
SVBY—Babbit Metal.
SVBZ—Miscellaneous.

The fifth letter of the symbol should be the particular kind of article in the subdivision shown by the fourth letter, as for example, SVB—Bars for various purposes, in which would be SVBB—Brass Bars for various purposes.

SVBBF—Flat or Rectangular Brass Bars.
SVBBH—Hexagonal Brass Bars.
SVBBN—Octagonal Brass Bars.
SVBBR—Round Brass Bars.
SVBBS—Square Brass Bars.
SVBBT—Triangular Brass Bars.

If a further subdivision should be necessary fully to describe an article, a sixth letter can be used. This letter should indicate the different manufactures or makes of the 5-letter symbol, and should be as far as possible the initial letter of the manufacturer's name or trade name of the articles.

The letters I, J, O, Q, and U should be omitted from all classifications, except in very rare cases where all other letters are exhausted, because in connection with figures adjoining the symbol letters, the I, O and Q might be mistaken for figures, and J and U might be mistaken for each other or for V.

A system as used in the storerooms of a large public utility in Oregon requires that all supplies be arranged into groups such as:

SC—Stores Conveyance.
SE—Stores Electric.
SG—Stores Gas.

This is made to include as many divisions as are advisable. Each group is further subdivided, the division being from the general to the particular, this is, each division subdivided the one it follows, as:

SCA—Stores Conveyance, Automobiles.
SEL—Stores Electric, Line Material.
SGP—Stores, Gas, Pipe.

As an illustration from the SEL group—Stores, Electric, Line Material—Poles are a subdivision of Line Material and again a wooden pole is a certain kind, hence SELP-W would be the symbol for a wooden pole, then again by inserting the size between P and W the symbol would be SELP 35 W, the symbol for a 35-ft. wooden pole. The "W" subdivision is not necessary for most cases, as a comprehensive classification may be had by going 4 places only.

In giving size, absolute uniformity should be followed as to dimensions indicated by the relative position of the figures. Some one method should be followed as, for example, when 3 figures are used in giving dimensions, they should be given in the order of length, breadth, and thickness. When one dimension only is given, it should always indicate thickness or diameter, that is, when one dimension is given it should always be the last dimension of the three. If 2 figures are given, these figures should be the last 2 of the 3 dimensions, the breadth being given first and the thickness last. In the case of cylindrical articles, when 2 figures are shown, and the last figure the diameter, first figure should be the length, and with tubing the first figure should be the length, the second the outside diameter and the third the gage or inside diameter. For all other cases, when 3 figures are given, they should always follow the order as above—length, breadth and thickness.

Whether this method of designating dimensions or the opposite is used (always giving the thickness or diameter first), is not so essential, as there are arguments in favor of each; but it is essential that some one method be adopted for general use.

The development of a complete and successful memory symbol system is not a matter of a day's or week's preparation, and its installation is not to be taken lightly or by those who have made no careful study of the subject. It can readily be seen that if the groups are not properly worked out before the physical changes in the storerooms are made, the result would be the same as mixing up a dictionary or the telephone book. The storeroom should be arranged so that each bin, section or space will follow up each other as do the pages in a dictionary. It is also best to arrange the general classification according to the nature and shape of the material so as to enable the storing, and later of locating the material desired to the best advantage.

Rules for Packing Rods

By A. D. Palmer

IN looking over old or discarded steam-driven machinery, such as pumps, engines, etc., the observant mechanic will soon notice that the wearing out of the rods is a common cause for the machine being discarded. This should not be, and as a general thing further investigation will disclose that excessive friction caused by too much pressure on the packings is responsible for much of this wear.

Many young engineers entertain an idea that setting up, or tightening, is the proper remedy for leaky stuffing-boxes. This idea results in excessive friction loads, excessive wear, improper operation of sensitive machinery (such as the governors on high-speed engines) and many unjust complaints against packings that, if given proper use, would give the best of results.

As a remedy, the following rules are posted on the wall of a large local plant, and they are worthy of consideration of anyone having work of this sort to do:

1. Be sure that packing is the proper size for the box that is to be packed.

2. In cutting rings, the joints, where possible, must lap, with ⅛ in. clearance for packings not over ½ in. wide and ¼ in. clearance for packings over ½ in. wide. (See Fig. 1.)

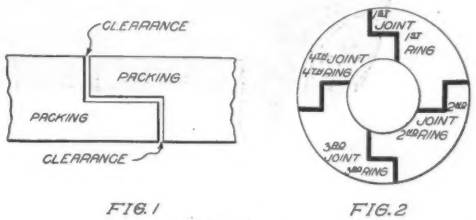


FIG. 1. METHOD OF LAPPING PACKING RINGS
FIG. 2. PROPER METHOD OF BREAKING PACKING JOINTS

3. Clean out all the old packing, and if possible, blow out the box with steam after all the old packing has been removed.

4. Dip packing in a thick mixture of graphite and cylinder oil, then place in box, and set up each ring with the gland until packing bottoms in the box. Have the joints set ¼ turn apart, as in Fig. 2. Fill the box until it is within one thickness of being filled, then insert gland, and set up cap, or yoke as the case may be.

5. Set up cap, or yoke bolts hand tight. If, when steam is turned on, machine seems to bind, set back on cap and if need be, remove a ring of packing. It is advisable to let steam blow by packing slightly for the first 24 hr. after packing. This will allow for the expansion of the packing. After one day's service, gradually take up (hand tight) on box until no steam shows.

6. Never use a wrench to set up box on new packing; use hand only.

7. See that lubricator is filled and working a little extra after machine is packed.

8. Where machinery can be operated by hand, operate when box is empty, and when filled, and adjust (before turning on steam) to get the easiest running position, thus reducing the friction to a minimum.

Murray "Duplex" Boiler

SCOTCH TYPE IMPROVED WITH HEAD AND TUBES AT REAR OF FURNACE

FOR years, the Scotch type of boiler with cylindrical shell, round, self-contained furnace and freedom from external brickwork has been deservedly a favorite because of its evident and acknowledged advantages and in spite of the undesirable lack of circulation in the bottom, which is not reached by the heat from the furnace. In this type there is freedom from unusual staying; no flat surfaces to catch oil and scale; parts are readily accessible; gas travel is simple and effective; first cost is reasonable, and large capacity can be put into small space.

In the Murray "DUPLEX" Boiler developed and patented by the Murray Iron Works of Burlington, Iowa, all the desirable qualities of the Scotch type have been retained and in addition the circulation has been improved, thus decidedly increasing the steaming capacity.

FIG. 1. SECTIONAL VIEW OF MURRAY "DUPLEX" INTERNALLY FIRED BOILER

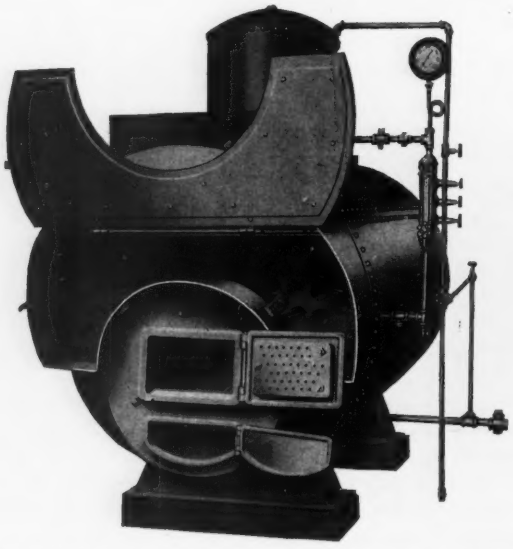


FIG. 3. "DUPLEX" BOILER IN SMALLER SIZES SHOWING SPACING OF LONG TUBES

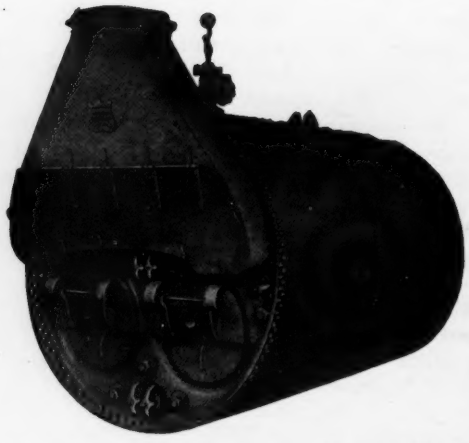


FIG. 4. FRONT VIEW OF LARGE SIZE "DUPLEX" BOILER

As seen in the sectional view, Fig. 1, the plain cylindrical shell requires no staying, and, as it is not subjected to external heat, the plates can be made of proper thickness to withstand any pressure, with riveted joints correctly designed to give a maximum of efficiency.

internal cylindrical furnace is used of Adamson ring or corrugated type depending on the pressure to be carried, the furnace being shorter than the shell to permit insertion of a rear furnace head which is connected by a nest of short tubes to the back head of the boiler. This construction diverts the flames downward, heating the rear and lower parts of the boiler, increases the circulation and adds materially to the heating surface. It also equalizes the heating of the shell at top and bottom, thus avoiding unequal expansion and contraction which cause strains and leakage.

Travel of the flames and the resultant circulation are shown in Fig. 2. After passing through the short tubes to the combustion chamber in the rear, the gases return through a nest of long tubes located at the sides of and above the furnace and extending from rear head to front head, and pass by the front uptake to the stack. Thorough mixing of gases is ensured by the passage through the short tubes, giving right conditions for completing combustion, for which there is opportunity during the sweep through the rear combustion chamber. As this

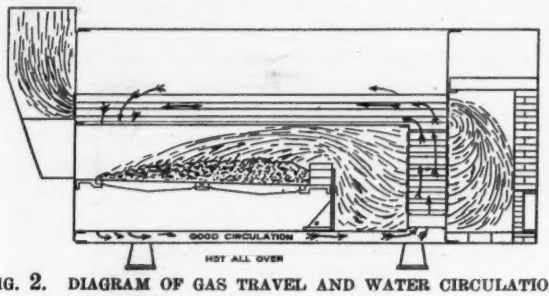


FIG. 2. DIAGRAM OF GAS TRAVEL AND WATER CIRCULATION

chamber is entirely surrounded by brick and contained within the steel casing, heat is reflected back against the rear head, rather than conducted away to the air, thus adding to the effectiveness of the rear head surface. And as all gas chambers and passages are inside the boiler shell, no chance is offered for inleakage of cool air or outleakage of heat through cracks or crevices.

Simplicity and accessibility are evident from Fig. 1. The diagonal staying of the heads leaves ample room in the steam space for free steam disengagement and circulation and for inspection or repairs. Doors, as shown in Figs. 1 and 3, give ready access to the tubes, all of which are straight, and to the uptake for cleaning, and handholes in front head and bottom of shell permit inspection and cleaning of furnace and shell. The chamber behind the bridge wall is reached from the grates and through a flue at the bottom of the nest of short tubes. These provisions make repairs easy and require only the most ordinary tools for cleaning and replacements.

Materials used as well as methods of construction conform to the rules of the insurance companies, and all boilers are given thorough test with water and steam conforming to insurance regulations.

The Murray "DUPLEX" boilers are built in sizes from 8 to 250 hp., and for pressures from 100 to 200 lb. For the sizes up to 50 hp. the plain cylindrical furnace is used suitable for 100 or 125 lb. pressure, arranged as shown in Fig. 3. This type of boilers run from 44 in. diameter by 6 ft. 10 in. long for the 8 hp. up to 60 in. by 13 ft. 5 in. for the 50 hp.

In the larger sizes, Fig. 4, 2 corrugated furnaces are used, the sizes running from 75 in. by 12 ft. 8 in. for 50 hp. up to 10 ft. 6 in. by 16 ft. 3 in. for 250 hp.

In a test of a 125-hp. boiler, 7 ft. 6 in. by 16 ft. 2 in., made by H. M. Jones and M. E. Finck at the Farmington, Iowa, Electric Light Plant with Iowa mine run coal from Farmington mines, on July 29 and 30, 1915, the results were as tabulated. The coal showed a heat value, dry, of 10,750 B.t.u. per lb., carried 6.5 per cent moisture and gave 19 per cent ash. The grate surface was 26 sq. ft. and heating surface 988 sq. ft.

TABLE. RESULTS OF TESTS OF MURRAY "DUPLEX" 125-HP. BOILER

Test No. Running	1 Pump	2 Pump & Lights	3 Rating
Duration, hr.	3.67	3	1
Wt. coal fired, lb.	1050	1535	450
Water fed to boiler, lb.	8240	8960	3770
Steam pressure, lb. gage	109.5	120.6	121
Feed water temp., deg. F.	141	141	151
Factor evaporation	1.1150	1.1174	1.1055
Equivalent evaporation from and at 212 deg., lb.	9187.6	10012	4167.73
Temp. of flue gases, deg. F.	460	496	487
Draft between uptake and boiler, in. of water	0.27	0.27	0.28
Horsepower developed	72.3	145	121
Per cent rating	57.8	116	96.8
Water evaporated per lb. of coal as fired, lb.	7.84	5.85	8.07
Equivalent from and at 212 deg., lb.	8.75	6.53	9.26
Equivalent evaporation from and at 212 deg. per lb. of dry coal, lb.	9.38	6.98	9.6
Equivalent evaporation from and at 212 deg. per lb. combustible, lb.	11.74	8.75	11.4
Efficiency of boiler and furnace based on dry coal, per cent	84	62.5	85

This test had to be made under rather unfavorable circumstances, as the boiler was only provided with a 40-ft. stack giving a poor draft; yet an efficiency of 88 per cent was obtained at rated load and an overload of 25 per cent was easily carried.

The Murray Iron Works Co. is an old established concern and has been building all kinds of boilers for the past 40 odd years, and while this boiler has only been on the market for a few months, there are now some 20 in successful operation.

U. S. CIVIL SERVICE COMMISSION announces an examination, April 11, for aeronautical engineer, to fill a vacancy in this position in the Signal Service at Large, War Department, at San Diego, Cal., at an entrance salary of $3600 per annum, and vacancies as they may occur in this position and in positions requiring similar qualifications in any branch of the service. Applicants must be graduates in mechanical engineering of some reputable technical school, must be thoroughly versed in the science of aerodynamics, and have had considerable experience in the design and construction of various types of air craft. Persons who desire this examination should at once apply for Form 1312, stating the title of the examination desired, to the U. S. Civil Service Commission.

Design of Fire Tube Boilers*

DANGEROUS FEATURES OF MODERN BOILER DESIGN AND HOW THEY MAY BE IMPROVED. BY F. W. DEAN

THE GREAT and usual cause of weakness in boilers is such a form of some part that, with the application and removal of pressure or with variations in pressure, this part bends first one way and then the other, and this causes cracks. It is in general the shells at the longitudinal joints which act in this way, and it is safe to say that nearly all explosions of fire tube boilers are caused by the bending and resultant cracking of this part of the shell. Occasionally a boiler corrodes sufficiently to weaken it to the breaking point, but this is very uncommon.

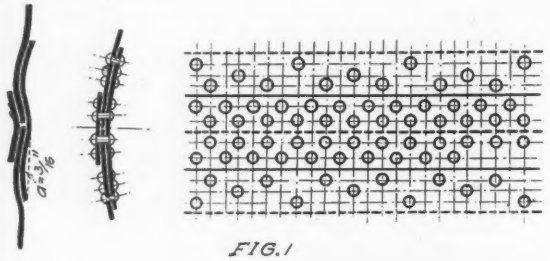


FIG. 1

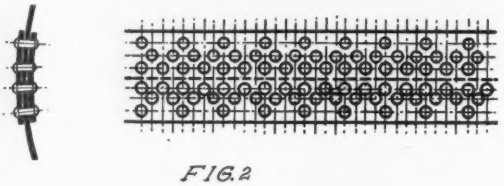


FIG. 2

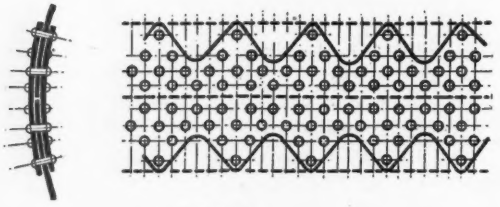


FIG. 3

FIG. 1. BENDING OF BUTT JOINT TESTED TO DESTRUCTION
FIG. 2. BUTT JOINT USED IN MARINE PRACTICE, EFFICIENCY ABOUT 85 PER CENT
FIG. 3. BUTT JOINT WITH EFFICIENCY OF 92 TO 94 PER CENT

The most prolific cause of explosions of fire tube boilers has been lap longitudinal joints, and the use of butt joints with inside and outside covering plates has, so far, done away with such explosions. The lap joint makes the boiler non-circular at and in the vicinity of the joint; and when pressure is applied the plate, in its effort to become circular, bends somewhat, and on the reduction or removal of pressure it tends to return to its original form.

While butt joints have prevented explosions, there have been cracks in the butt joints of 4 horizontal return tubular boilers, and their leakage gave warning so that the boilers were taken out of service before they exploded.

It is of the utmost importance to design butt joints that will not bend in service. The joint which has a narrow butt strap on one side of the shell and a wide one on the other, is one-sided, and its center of resistance does not coincide with the center of pull of the shell plate. That part of the wide strap which extends beyond the narrow one is riveted to the shell, and this outer part of the joint is a lap joint with its peculiar defects. The rivets in this part of the joint are overhung and in service tend to tip over and bend the joint. Fig. 1 shows how this bending occurs when such a joint is tested to destruction, this being the result of several actual tests.

In order to prevent a joint from bending, a butt joint with straps of the same width and with all rivets

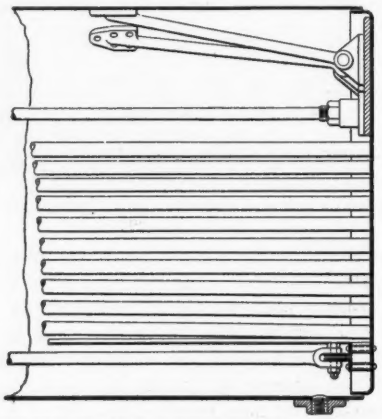


FIG. 4. DIAGONAL AND LONGITUDINAL STAYS WITHOUT OUTSIDE NUTS

in double shear should be used, as is always done in Europe. The center of resistance of such a joint coincides with the center of pull in the shell. There are various designs of such joints ranging from the simplest joint with double covering plates of equal widths, to the joint shown in Figs. 2 and 3.

Figure 2 illustrates a design which is used largely in marine practice in this country and abroad and which has a theoretical efficiency of about 85 per cent. Figure 3 shows a more efficient joint, having a theoretical efficiency of from 92 to 94 per cent. In the joint in Fig. 3 the outer strap is cut away between the rivets in order that it may stand calking; the high efficiency is secured by the wide pitch of the outer rows of rivets.

BENDING PLATES

ON ACCOUNT of the difficulty of bending plates to an exact circular form out to the edges, it has been customary to hammer the edges to this form. The result is that the plate is injured and the shape is only approximately exact, and this occurs at a part of the boiler that

*Abstract of paper read before the A. S. M. E.

is in every respect the weakest and most troublesome. In some shops methods are taken to minimize this defect; the ends of the plates are pressed into shape.

Braces

Through rods above the tubes of horizontal return tubular boilers should be supported so that they cannot vibrate, and the supports should be stiff enough to prevent movement in any direction, instead of merely supporting the weight. If any braces are used below the tubes, through or head-to-head braces, rather than braces riveted to the shell should be employed. Such braces should not, however, pass through the back head on account of the nuts being in contact with the fire. The rods should be secured to angles riveted to the back head but separated from it 2 to 4 in. by ferrules around the rivets, in order to permit the removal of dirt between the angles and the head.

It is best not to have the rods above the tubes pass through the back head, because the nuts interfere with an efficient method of covering the back connection with fire brick. There are various ways in which nuts can be avoided, and Fig. 4 shows methods of staying both above and below the tubes. In the former case diagonal braces are used for staying the upper parts of the tube plates in order to give more room for inspection, and the heads are stiffened by riveting on thick plates. In England plate gusset stays are preferred to through rods or diagonal stays, but in this country they are seldom used.

Rivet Holes and Riveting

Riveting is now generally done by hydraulic machines, which have shown themselves superior to any other kind. In consequence of the slow movement of a hydraulic plunger the rivets have time to enlarge and fill the holes; and from the solidity of action and steady holding power of the machine the plates are firmly pressed together, with the result that joints riveted by this type of machine are tighter than those made by any other.

It is the common practice in this country to punch the holes of boilers ⅛ in. or ¼ in. small and then to drill them to size with all plates and covering plates in place. This is a great advance in practice over punching to size, but it is not satisfying to the imagination and it may be one reason why plates exposed to the hottest gases crack between the rivets and their edges. Another reason for such cracking may be bulging caused by too much pressure by the riveting machine on the rivet. Sometimes such bulging is very apparent.

A still further advance in practice is to punch one butt strap for each joint with small holes and use it as a template for drilling not only itself but the main plate and the other butt strap. Similarly, the holes in one plate of a circular seam may be punched small and used for a template for drilling the other holes. The best way, however, and the one which I hope to see adopted everywhere, is to drill all holes from the solid.

The conical rivet head is being displaced by one of more or less spherical form which has the advantage over the former in having a thicker edge and increased holding power.

Reinforcing Plates for the Outside Fireboxes of Vertical Boilers

Above the staybolt level of vertical boilers the outside fireboxes are subjected to the full stress that comes from the steam pressure unreduced by any connection to the inside firebox by the staybolts. In some designs the whole outside firebox is made of the thickness required to stand the pressure as if unstayed; in other designs there is a short course of increased thickness just above the staybolts, and in still another design the outside firebox plate is thin for its whole height and is reinforced above the staybolts by riveting a band of steel around the inside of the plate.

I disapprove of the last of these methods. Shell explosions are nearly always caused by the bending of the plates, and the inside reinforcing plates of vertical

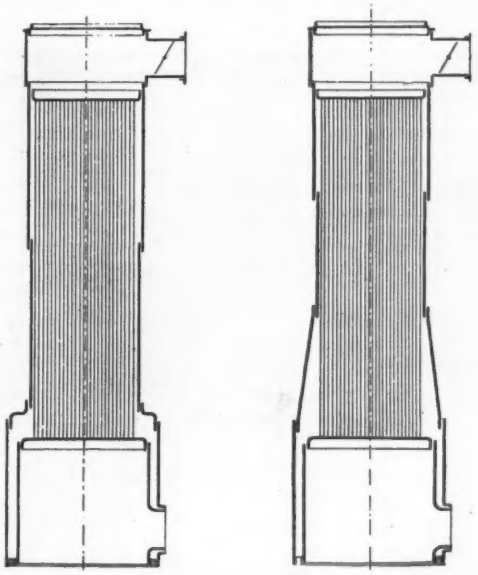


FIG. 5 FIG. 6

FIG. 5. VERTICAL BOILER WITH REVERSED FLANGE
FIG. 6. VERTICAL BOILER WITH CONICAL COURSE

boilers, just described, can do no good without bending. They cannot then prevent the main plates from being overstrained, and they are, therefore, possible causes of explosions.

Reversed Flanges in Vertical Boilers

On account of the ease with which the reverse flange used in some types of vertical boilers bends, this type of boiler elongates when subjected to pressure, and, under test pressure, to a considerable extent. Even the pulsations in pressure coming from the opening and closing of the inlet valves of steam engines cause the boiler to change its length each time, and this action and others have caused many of the reversed flanges to crack. The effect has been reduced by making this flange of a less flexible form and increasing its thickness. It is not a good plan, however, to have flexible means of connecting the ends of boilers, and when the flange is made so thick that it is not flexible its object is no longer accomplished.

Another harmful effect of the elongation of boilers of this type is the bending of the lower tube plate upward and the upper one downward. This tends to pull the outer tubes from the tube plates and may cause explosions.

In order to obviate the 2 defects described, the reduction in diameter should be made, as it has been many times, by a conical course, Fig. 6, instead of by a reversed flange. An incidental advantage of this is that the circulation of the water is a little freer.

Dished Heads for Steam Drums

Several explosions have been caused by dished heads cracking around the edges where they join the spherical portions. There is no doubt that such heads breathe and that the cracking is due to this. I believe that such heads should be made of thinner plates than usual and braced like flat heads.

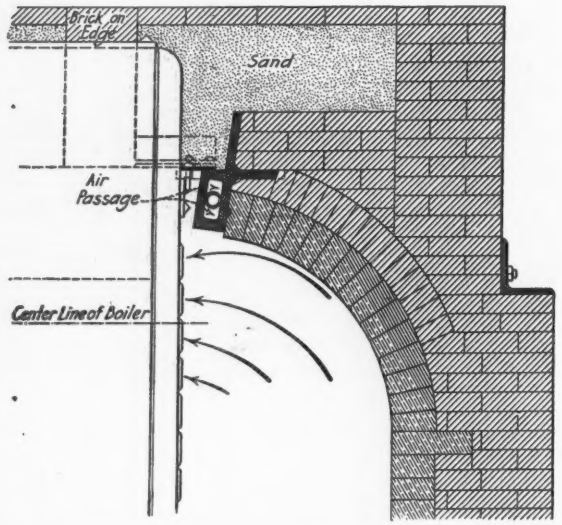


FIG. 7. WOOLSON'S GAS-TIGHT BACK ARCH CONNECTION

In regard to the method of bracing such heads, I am inclined to think that radial plate gussets would be best, and, if placed at equal distances completely around the drum, the latter would not be distorted by supporting the head. I think that anybody who has a boiler with unbraced drum heads should view them with anxiety.

Flush Head Horizontal Return Tubular Boilers

In New England horizontal return tubular boilers are always built with the front tube plate flanged forward, but in other parts of the country it is frequently if not usually flanged backward. The latter is known as the flush head or New York boiler. I consider the New England method the better because all the riveting can be done by machine. With the other construction, one circular joint must be riveted by hand or pneumatically. Another advantage of the New England method is that it makes a tight smokebox, while the other, especially if the boiler has a brick smokebox, which is usually the case, is likely to leak air. A leaky smokebox diminishes draft and cools the gases and thus diminishes the effect of an economizer if one is used.

Brickwork

A desirable feature of brickwork enclosing boilers is the absence of cracks. The brickwork should not touch the boiler anywhere, and the space between it and the boiler should be stuffed with asbestos fiber. Although this filling may tend to leak air, the covering over the top of the boiler, which rests on the brickwork, prevents this. The front end of the boiler should be fixed, and the other end should have attached to it some back connection covering device which will slide and not tend to push the back wall over. Such a device has been made by Orosco C. Woolson, and is reproduced in Fig. 7.

It is common to use buckstays on the sides of boiler settings, but I also use them on front and back in order to prevent cracks. Buckstays should be usually of 8-in.

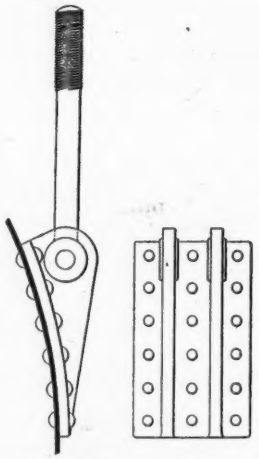


FIG. 8. BOILER SUPPORT SHOWING GOOD DESIGN OF LUG

I-beams of the lightest section, instead of cast iron which is unreliable. If it is advisable to use spaces in the walls in order to prevent cracking of the brickwork, it is best to fill them with some material, such as ashes, crushed brick, sand or other loose material, which will entrap air but diminish its movement. Solid brick walls form a better non-conductor than walls with air spaces.

Method of Supporting Horizontal Return Tubular Boilers

Horizontal return tubular boilers, no matter what their length or size, should be supported at no more than 4 points. If boilers are long it is common to support them at 6 points. In order to prevent the end supports from leaving their bearings, springs are often placed under the middle brackets, but this does not render the pressures on the supports equal.

In supporting a horizontal boiler the 3 point principle should be applied. To obtain this effect and yet have the boiler held up at 4 points, 2 points at one end are supported in the usual manner and the other 2 points are connected by links to an equalizing lever working on a pin passing through overhead supporting beams.

Brackets or lugs used on boilers for suspension from above should have the point of support close to the boiler and the direction of the link nearly or quite tangential to the shell, as shown in Fig. 8.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Direct-Current 3-Wire Machines

BRIEF DISCUSSION OF APPLICATION, CONSTRUCTION AND OPERATION OF 3-WIRE GENERATORS; USE AND THEORY OF BALANCERS AND THEIR INTERNAL AND EXTERNAL CONNECTIONS. BY GORDON FOX

PAST experience in the industrial application of direct-current motors has proven 230 v. the most suitable pressure to employ for that purpose. The wiring for 110 v. motors requires too much copper; the 550-v. motor is a little too sensitive and subject to commutation troubles. On the other hand, the best illumination units are available for 110 v. only. The requirements for the 2 applications, power and lighting, thus differ. A compromise involves a sacrifice in efficiency. As a result 3-wire systems furnishing 230 v. to the motors from the outside feeders and 115 v. for lighting service from either outside line to a third intermediate lead commonly termed the neutral, have been extensively adopted. The lighting load is usually so distributed and connected that it will tax the 2 sides of the system equally, and, since this load is usually much less than the motor load, unbalancing of the system is not likely to be of much consequence.

There are a number of methods for supplying the double voltage for 3-wire systems. If the power is generated upon the premises where it is applied, the ordinary 3-wire generator is most generally used. This is essentially a standard 230-v. machine with the exception that the shaft carries collector rings connected to taps from the armature windings; there may be 2 or more rings connected to 2 or more taps. Where the unbalancing will be small, a design using 2 rings is satisfactory, while for greatly unbalanced loads the 4-ring type is preferable. In the 2-ring machine the taps are 180 electrical degrees apart, giving a single phase arrangement; in the 4-ring machine the taps are 90 electrical degrees apart so that a 2-phase arrangement is secured. Leads from the collector rings are connected to an auto transformer known as a compensator. The leads from the collector rings are connected to the 2 terminals of this compensator, while the neutral wire of the system is tapped in at a central point of its winding. The collector rings deliver an alternating voltage to the compensator, the resulting current magnetizing the iron and inducing a counter voltage such that only a small magnetizing current flows through the compensator coil. With an unbalanced load on the system direct current passes through the compensator coil, collector rings and a portion of the armature winding. The greater the number of armature taps the more evenly this unbalanced load is distributed among the armature coils, hence the more uniform the heating effect and the better the voltage regulation. It is for this reason that the 2-phase arrangement using 4 taps and 4 rings is preferable to the single-phase arrangement. The 2-phase system utilizes but a single compensator, this being of 2-phase design. Recently there has been brought out a line of 3-wire generators having the compensator built into the spider of the armature, the neutral being brought out through a single collector ring. And as with this design the armature may be tapped at a number of points for a multiphase compensator, the advantages of good voltage regulation and uniform heating are secured without the disadvantages of a large number of collector rings and leads.

The limit of allowable unbalancing for most 3-wire generators is 10 per cent; they will maintain the neutral voltage within a 5 per cent range. They are ordinarily compound wound and may have a rising, flat or drooping characteristic, as desired. The series field is usually

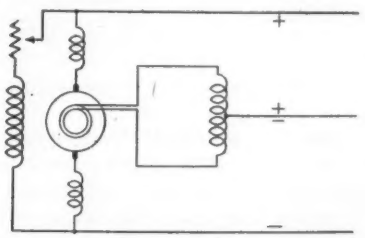


FIG. 1. DIAGRAM OF CONNECTIONS OF A COMPOUND-WOUND, 3-WIRE GENERATOR WITH COMPENSATOR COIL

divided into halves, one half being connected in each of the outside line leads. This averages the compounding effect of an unbalanced load, adjustments of compounding being applied equally to the 2 halves. The connections of a single 3-wire generator are shown in Fig. 1.

Three-wire machines may be paralleled in the same manner as 2-wire generators, 2 equalizers being, however, required because of the division of the series fields. In proportioning the resistances of the circuits between equalizers and outer feeders to adjust the load division, both sides of the machine are affected. When 2-wire direct-current machines are paralleled the ammeters and circuit breakers are always connected in the armature circuit, not in the series-field circuit. Both sides of a 3-wire machine are series-field sides, consequently leads must be run from the armatures to the

ammeters and breakers, returning then to the series fields. This prevents equalizer currents from affecting the ammeter readings or the circuit breakers.

Balancers

Frequently 230 v. power is purchased where 3-wire service is desired. It then becomes necessary to introduce a means for maintaining locally a fixed neutral midway between the 230-v. leads of the system. Some type of "balancer" or "equalizer" set is commonly supplied to meet this need. These sets are of several types, differing mainly in the arrangement of their field connections. They are nearly all motor generators composed of 2 duplicate units, coupled together and mounted on a common bed plate. The armatures are wound for 115 v., and are connected in series across the outer leads of the system. The common point between the 2 armatures is the neutral.

The fields of shunt-wound balancer sets may be designed either for 115 or 230 v. If wound for the latter they are simply paralleled across the line. If, however, wound for 110 v., they are connected in series. Their central point may or may not be connected to the

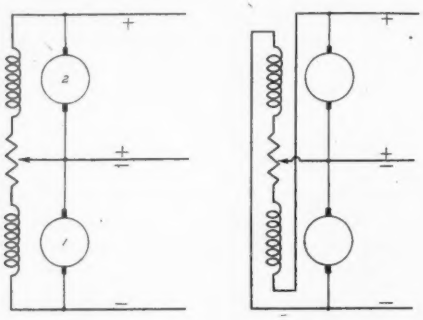


FIG. 2. DIAGRAM OF CONNECTIONS OF SHUNT-WOUND BALANCER SET

FIG. 3. DIAGRAM OF CONNECTIONS OF SHUNT-WOUND BALANCER SET WITH INTERCHANGED FIELDS

neutral. Figure 2 is a diagram of connections for a shunt-wound set. Its operation is as follows: When the load is balanced both machines run light as motors. If an unbalanced load exists between the neutral and the negative line, machine 1 acts as a generator and machine 2 as a motor, the armature currents of the 2 machines combining at the neutral to furnish the extra current for the heavily-loaded side. Armature 2 carries, in addition, sufficient current to supply the losses of the set. When the 2 machines are running light their speed is such that their counter voltages nearly equal the impressed voltage. Unbalanced load causes the voltage of the heavier loaded side to decrease so that it is less than the generated voltage of the balancer unit connected across that side. This balancer unit then becomes a generator. The voltage across the other unit of the set is increased so that it exceeds the counter voltage materially, thus enabling it to carry the load imposed by its mate. It will be seen that the action of the set is merely to shift from one side of the line to the other side a load sufficient to compensate for the unbalancing of the external system.

The excitation of a shunt-wound balancer set having the fields connected either in parallel or series across the outer lines is practically constant. The shifting of load must therefore be accomplished only by a change of speed brought about by changes of voltages from neutral to the outer lines. Consequently a considerable shift of the neutral is required to affect this action. If the central point of series-connected shunt fields be connected to the neutral of the system, the result will still be unsatisfactory in many ways. The loaded side of the line drops in voltage and the unit across it becomes a generator. The excitation has been decreased by the drop in voltage so that a material increase in speed of the set is required to secure generator action. But the motor unit of the set has had its excitation increased by the rise in voltage across that side of the line. The speeding up of the set is thereby hindered. The 2 actions combine to prevent quick and close regulation of the voltage. This, however, can be largely overcome by interchange of fields as shown in Fig. 3, in which the generator voltage is upheld by the increase in field strength while the motor speed is main-

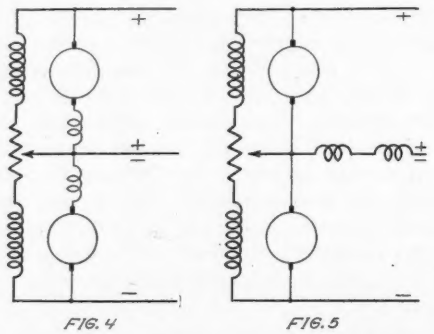


FIG. 4. WITH THIS FORM OF COMPOUND WINDING THE DIFFERENTIAL ACTION UPON THE MOTOR IS GREATER THAN THE CUMULATIVE ACTION UPON THE GENERATOR

FIG. 5. SERIES FIELDS CONNECTED IN THIS MANNER PROVIDE IMPROVED STABILITY OVER THAT SHOWN IN FIG. 4

tained or raised by the decrease across that unit. This connection of the shunt fields gives quite satisfactory service and is in most cases an exceedingly satisfactory connection for shunt-wound balancer sets.

In the case of compound-wound sets, we must consider the fact that each unit operates part of the time as a motor and part of the time as a generator so that the current through the armature and series fields is frequently reversed as conditions of the load are modified. The series field of the motor unit opposes its shunt field while the series field of the generator unit assists its shunt field. The motor speed is maintained or increased by the differential action and the generator voltage is built up by the cumulative action of the generator unit. The tendency is thus toward good regulation. The series fields may be connected in a number of ways. The differences in action are mainly due to the fact that the motor armature carries a greater current than the generator armature, supplying as it does the losses of the set. If the set is connected as in Fig. 4, the differential action upon the motor is

stronger than the cumulative action upon the generator. There is then a tendency toward unstability and racing. The connection shown in Fig. 5 enables both series fields to carry the same load currents, consequently there is an improvement in stability. The series fields may be interchanged as shown in Fig. 6, in which the cumulative action upon the generator is stronger than the differential action upon the motor. The excess compounding effect is shifted from motor to generator unit, the stability is good and the voltage regulation is likely to be better with the other series-field connections. There are a number of combinations of shunt- and series-field connections which are not here given. The principles are the same as here apply, and the comparative action may readily be seen by studying the action of the 2 fields separately. The action is also modified according to the degree of compounding afforded. Most balancers are flat compound-wound. If the set is feeding into long leads having considerable drop it may be allowable to adjust for 5 per cent overcompounding, which is about the greatest degree of overcompounding allowable for most sets. The compounding is controlled by German-silver shunts connected across the series fields the same as for any direct-current compound-wound machines.

As each of the units of a balancer set operates a portion of the time as a motor and a portion of the time as a generator, the neutral position of the brushes is being constantly shifted. The neutral of a generator shifts with the direction of rotation, while that of a motor shifts against the direction of rotation. The set rotates continually in one direction, so that the load neutral is sometimes in advance of the no-load neutral and sometimes behind it. The motor end of the set carries the greater load. It is therefore good practice to set the brushes of each unit slightly off the no-load neutral, favoring motor action. In an interpole motor or generator the neutral remains fixed at the no-load neutral point. Interpole machines are therefore well fitted to meet the condition of interchangeability imposed in balancer sets. Commutation is the limiting feature in the rating of non-interpole sets. Interpole sets may be more closely rated on the basis of heating. There is a possibility of instability in interpole sets, particularly if they are compound-wound. The interpole tends to maintain the speed of the motor. In addition there is the differential action of the series field. If the compounding is too great or the interpole too strong, racing may result. Non-interpole machines have the brushes set in a compromise position in a direction with the rotation from the full-load neutral for motor action. Consequently the speed of the motor unit is retained and racing prevented. Both the speed control and the voltage control of balancer sets of all types can be slightly modified by adjustment of the brush position. It is the best practice so far as possible to set the brushes mainly for good commutation.

Operation of Balancer Sets

The operation of starting a balancer set is simple. The fields are first connected across the 230-v. lines with their central point (if series connected), disconnected from the neutral of the set and of the system. A starting box is connected in series with the 2 armatures which are themselves in series. By means of this starting box the units are quickly accelerated, both acting as motors. Next the central point of the fields is connected to the neutral of the set and, by means of a field rheostat provided for the purpose, the voltage is adjusted for equal division. The neutral of the set is then connected to the system neutral and the unit is in service.

Balancer sets may be and frequently are operated in parallel. In order to fulfill this service satisfactorily, careful adjustments must be made when the sets are installed. The same method of connection must be used in order that 2 or more sets will have similar characteristics. For compound-wound sets one or more equalizers will be required. The connection shown in Fig. 5 demands a single equalizer, while connections shown in Figs. 4 and 6 require 2 equalizers. Care must be exercised to connect the equalizers to corresponding points of the 2 sets. A previous statement calls attention to the fact that ammeters and circuit breakers must not be connected in the leads from the series fields of paralleled machines, since cross currents through the equalizers will then affect them. To carry out this requirement without extra wiring, the series fields of balancer

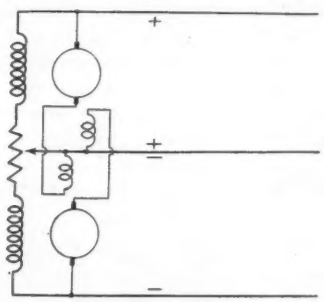


FIG. 6. INTERCHANGED SERIES FIELDS PROVIDE STRONGER CUMULATIVE ACTION ON GENERATOR THAN DIFFERENTIAL ACTION ON MOTOR

sets for parallel operation are connected next to the neutral. The meters and breakers are then connected in the outer leads. The load division of the sets must be adjusted by control of the resistance of the circuits between equalizers and neutral following the same rules as apply to the paralleling of any direct-current generators. Adjustment of these circuit resistances controls the division of current among the different series fields. This in turn controls the voltage regulation. The unit having the tendency for close regulation will tend to assume the load as unbalancing occurs on the system. In making the adjustment the action of each series field must be borne in mind as affected by the connection method used.

The points brought out in the foregoing discussion can probably be most clearly fixed if we consider an example. Let us assume that we have before us 2 compound-wound, interpole balancer sets to be adjusted for parallel operation as well as for close voltage regulation. We will go through the steps in the process of adjustment. First connect one end of the machine as a motor and shift the brushes to the no-load neutral, located by reversing the unit several times and so fixing the brush position that the no-load speed would be the same for both rotations. Repeat this operation upon

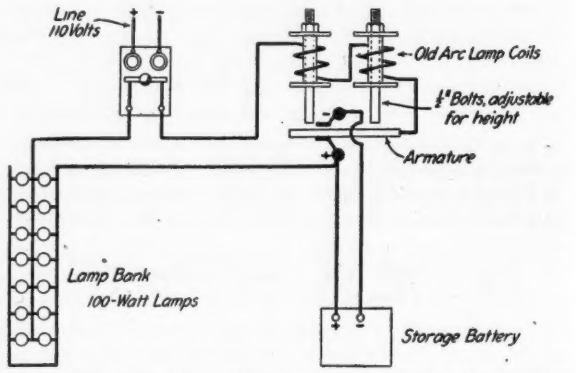
the other unit of the set. Next connect one unit as a motor and the other unit as a generator, the 2 armatures being electrically disconnected. The fields would then be connected as in service according to the scheme intended in the design. Load the generator by an external load and note the speed and voltage regulations. If sparking or racing occur, the interpoles may be too strong or even reversed. Assuming that the interpoles are properly connected, their strength can best be determined by means of a low reading voltmeter and exploring leads as described on page 265 of the March 1, 1915, issue of Practical Engineer. The interpoles being properly adjusted, the series windings can be given attention. If the voltage-regulation curve is not flat, particularly if the motor tends to speed up unduly, the series windings of the unit should be shunted, both with duplicate shunts, the resistance of which can be determined by trials until the voltage regulation is as desired. Connect the set as a balancer and try out its action. Bring it up to speed and adjust the field rheostat so that the voltages of the 2 units are identical; then throw on full unbalanced load, first upon one unit, then upon the other, noting the voltage regulation. If it is not exactly as desired we can probably control it by changing the shunts across the series fields. If this does not meet requirements, a change in the connection scheme might be employed to advantage. Having adjusted both sets singly to give satisfactory performance, they may next be operated in parallel. If they do not divide their loads proportionately, it will be necessary to insert resistance in some circuits between equalizers and neutral as before mentioned.

Balancer sets may be protected from damage in a number of ways, the method selected depending upon the importance of uninterrupted service as compared with the likelihood of damage to lamps or other apparatus connected to the 115-v. system. Lamps are more easily damaged by overvoltage than are motors or heating devices. Fuses in the outer leads are the cheapest protection. A circuit breaker in the neutral lead working through a relay to operate breakers in the line leads protects the set by disconnecting the power when an excessive unbalanced load is imposed. A differential voltage relay will prevent excessive voltage variations from injuring the connected equipment by tripping the circuit breakers in the lines and disconnecting the set.

The size of the balancer set required for a plant depends upon the layout and local conditions. The degree of unbalancing probable depends upon the arrangement of circuits, whether they are 2- or 3-wire, whether the dark side and the light side of the building are connected upon different sides of the system, whether the interior parts of the building are connected to one side and the portions near the windows to the other side, and to similar features. It is well in laying out a plant to include one or 2 small 2-wire lines which may be connected to 2-way switches on the board so that they may be thrown as desired to help maintain the balance of the system. As a general rule, the balancers installed are capable of handling 10 per cent unbalanced load, that is, they will carry 1/10 of the connected load all on one side of the line. Each unit of the set has a capacity equal to half the rated unbalanced load plus the losses of the set.

Automatic Battery Switch

A FEW years ago the writer was in charge of the electrical installation of a paper mill. The company operated a number of gasoline tugboats which used storage batteries for lighting and ignition. The current for charging these batteries was taken from a direct-current generator belted to a large Corliss engine. This engine was started and stopped as often as 20 times a day, so that when the generator stopped the batteries on charge



WIRING FOR DEVICE TO MAKE AND BREAK CHARGING CIRCUIT OF STORAGE BATTERY

would return current to the line unless the circuit was opened. To prevent this the scheme shown in the accompanying illustration was devised, which would automatically throw the battery in the charging circuit when the generator started and out again when it shut down. The outfit shown operated with a current of from 2 amp. to 14 amp.—PAUL CAPRARO IN Electrical World.

Peculiar Motor Trouble

THE FOLLOWING account of an electrical trouble may be of interest to the readers of Practical Engineer because of its peculiar nature.

A polyphase induction motor used to drive a line shaft was always started without a compensator by throwing the switch in and out several times until full speed was reached. One morning, the motor was started when the tone of the familiar hum changed enough to indicate something was wrong. Upon inspection it was found that the motor had blown a fuse and was running as a single-phase machine. Until, after having blown a number of fuses, it was found that unless the switch was thrown in faster than usual and hard, matters would not be remedied any. Inspection disclosed the fact that the switch blades were not lined up right, so that only 2 blades were in contact with the clips until the first one was in as far as it could go when the last one only half entered its clip. It is probable that the heat resulting from this poor contact opened the circuit and caused the motor to single-phase in the first instance. The only remedy was to make a more rugged switch, after which no more trouble was experienced.

H. E. WEIGHTMAN.

A FIRM IN England writes to the Bureau of Foreign and Domestic Commerce that it desires to be put in touch with American manufacturers of electric lamps.

Fire Fighting and Fire Prevention--IV.*

SPECIAL FEATURES AND DESCRIPTION OF CENTRAL STATION ALARM SERVICE. BY FRANK WILLIAMS

THE main features of the sprinkler alarm system as described are, of course, the alarm valves which sound a warning when a flow of water occurs or in other words when one or more sprinkler heads have operated whether through fire or accident. Ordinarily this alarm would only be transmitted to the engineer's office, and in order to eliminate the personal element as far as possible, in receiving the gong signal, a central station alarm service has been resorted to at a cost of

FIG. 1. NO SMOKING SIGN

$400 a year. Thus when a flow of water is caused in the system, in addition to the local alarm, a signal is directly transmitted to the central station where it is automatically received and recorded and then relayed to the fire department.

In addition to the above, a watchman is always on duty when the lofts are closed. In this connection, 3 combined watchmen's supervisory and break glass fire

THIS VALVE CONTROLS
SUPPLY TO AUTOMATIC SPRINKLERS
EAST SECTION ON THIS FLOOR
AND MUST ALWAYS BE KEPT
OPEN
TO BE HANDLED IN CASE OF EMERGENCY ONLY
BY THE FIRE PATROL OR THE EMPLOYE
CARING FOR THE EQUIPMENT
WHEN MAKING NECESSARY REPAIRS GIVE NOTICE TO
AND OBTAIN CONSENT OF THE
NEW YORK INSURANCE EXCHANGE

FIG. 2. TAG FOR CONTROL VALVE

alarm stations are located at various points within the building and the watchman is provided with a key for their operation. Every hour, the watchman traverses the building and inserts the key in the box station. This signals automatically to the central station, that "all's well" in that section where the box is located.

Should the watchman through neglect or accident fail to send the signal of his rounds at the stipulated hour, 15 min. grace are allowed and then if the observer at the central station does not find the round recorded, an inspector is immediately sent to the premises. For such investigation, when made necessary through the neglect of the watchman, he is penalized 50 cents every time it occurs. In case the watchman discovers a fire, in any part of the building, it is his duty, regardless of the other means of protection provided, to send in a fire alarm by means of one of his boxes, which signal is then automatically received at the central station and then relayed to fire headquarters. This service including the watchman's wages, amounts to $962 a year.

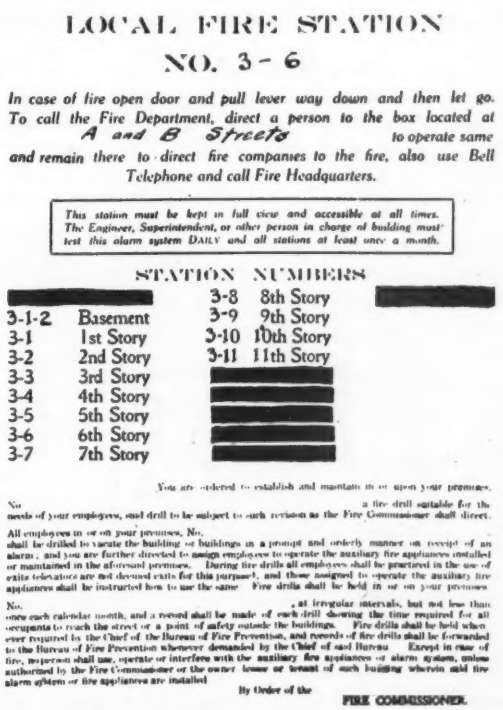

LOCAL FIRE STATION
NO. 3-6
In case of fire open door and pull lever way down and then let go.
To call the Fire Department, direct a person to the box located at
A and B Streets to operate same
and remain there to direct fire companies to the fire, also use Bell
Telephone and call Fire Headquarters.
This station must be kept in full view and accessible at all times.
The Engineer, Superintendent, or other person in charge of building must
test this alarm system DAILY and all stations at least once a month.
STATION NUMBERS
3-1-2 Basement
3-1 1st Story
3-2 2nd Story
3-3 3rd Story
3-4 4th Story
3-5 5th Story
3-6 6th Story
3-7 7th Story
3-8 8th Story
3-9 9th Story
3-10 10th Story
3-11 11th Story
You are ordered to establish and maintain at or upon your premises,
No. a fire drill suitable for the
needs of your employees, said drill to be subject to such revision as the Fire Commissioner shall direct.
All employees in or on your premises, No.
shall be drilled to vacate the building or buildings in a prompt and orderly manner on receipt of an
alarm; and you are further directed to assign employees to operate the auxiliary fire appliances installed
or maintained in the aforesaid premises. During fire drills all employees shall be practiced in the use of
exits (elevators are not deemed exits for this purpose), and those assigned to operate the auxiliary fire
appliances shall be instructed how to use the same. Fire drills shall be held in or on your premises
No. at irregular intervals, but not less than
once each calendar month, and a record shall be made of each drill showing the time required for all
occupants to reach the street or a point of safety outside the buildings. Fire drills shall be held when
ever required by the Chief of the Bureau of Fire Prevention, and records of fire drills shall be forwarded
to the Bureau of Fire Prevention whenever demanded by the Chief of said Bureau. Except in case of
fire, no person shall use, operate or interfere with the auxiliary fire appliances or alarm system, unless
authorized by the Fire Commissioner or the owner, lessee or tenant of such building wherein said fire
alarm system or fire appliances are installed.
By Order of the
FIRE COMMISSIONER.

FIG. 3. DIRECTIONS FOR BOX OPERATION

In connection with these outside services it should be remembered that the central station people furnish, install, and maintain all the required apparatus for the annual consideration named; but the ownership of the equipment always remains with them. All such central stations are under the strict surveillance of the various insurance interests and are equipped to receive and record automatically all signals transmitted from the building and to relay such signals as may be necessary. They also maintain a corps of operators and inspectors who are on duty at all times and forward reports of all signals received from the building.

As an auxiliary to the various equipments heretofore enumerated, each tenant is required to equip such area as may be occupied by him with the "Old Oaken Bucket"

*Continued from page 246, March 1 issue.

system, that is fire pails filled with water; but in lieu thereof, some chemical fire extinguishers are allowed, both being intended for use when a small fire is discovered and while it is still in its incipiency.

The number of fire pails distributed throughout any part of the building and always filled with water is in the proportion of 12 pails of 10 to 12 qt. capacity for every 5000 sq. ft. of floor space. They are hung on the columns and walls or set on shelves not over 5 ft. above the floor measuring to the top of pail and not less than 2 ft. above floor measuring to bottom of pail. Three pails, and one water filled cask of at least 60 gal.; or 6 pails and one approved portable chemical fire extinguisher, may be installed in place of 12 pails; in no case, however, can more than ½ of the pail equipment be displaced by chemical extinguishers.

Some of the general features maintained in the building, either by the tenant or owners which are conducive to fire protection and should be observed in all manufacturing building establishments, are as enumerated below.

SUMMARY OF COSTS

Item	Number	Total $	Unit Cost $	Cost per 1000 sq.ft.	Cost per 1000 cu.ft.
Exits	34	$225	$6.62	$0.72	$0.056
Fire Doors	34	1190	35.00	3.81	0.298
Fire Shutters	72	2436	33.85	69.60 *	1.453 *
Fire Pails	720	448	0.62	1.43	0.112
Stand Pipe System	37	3110	84.05	9.97	0.777
Sprinkler System	3780	32000	8.47	102.57	8.000
Fire Alarm	40+	1600	40.00	5.13	0.400
Totals	---	$41,009	---	---	---

Supervisory Service --------$1362 per year
Labor, Upkeep & Repairs----- 248 " "
$1610 per year for maintenance.

Notes:
*Based on area protected by shutters.
+Equivalent number of Box & Gong stations.

Stair and elevator doors are kept in good repairs, and all holes in shafts immediately sealed.

All inner non-fireproof partitions, not protected by sprinklers on both sides, are cut down to 18 in. below the ceiling and may be covered with thin cloth, paper or wire mesh if desirable.

Stock and merchandise are so piled or placed as to be not less than 2 ft. below bottom of floors or beams. No material is stored on or above sprinkler pipes.

Wood clothes closets are provided with thin cloth, paper or wire mesh in place of the usual wooden tops. Nothing must be piled on top of closets, and steel lockers are generally recommended.

Waste cans are provided wherever oily waste is used, and metal packing bins are used where such material as excelsior is handled. Safety cans are provided for th estorage and handling of benzine, but not more than 5 gal. are permitted on any one floor.

Signs telling that smoking on premises is not allowed, are posted in conspicuous locations throughout the building.

Benches without sprinkler protection underneath are arranged with a clear space of at least 3 in. between back of benches and walls.

Fire stops are installed under all tables, even sewing machines, larger than 4 ft. wide by 10 ft. long. These are made of No. 24 gage galvanized iron, the partitions being spaced 10 ft. apart and extend from underside of table to floor and from front edge to back edge, all securely fastened and reinforced with angle iron.

Elevator motor rooms, not being sprinklered, are kept clear of all materials and appliances other than elevator machinery.

Cleanliness is given especial attention with extra care for nooks, corners and under benches. Sweepings are kept in metal barrels or ash cans.

In parts where acid fumes may attack the sprinkler system, the pipes are given 2 coats of acid-proof paint to prevent corrosion, but the sprinkler heads proper are not treated.

To make sure that the various systems and appliances are kept in good working order, ready for emergency, the chief engineer of the premises has been charged with the duties of making or supervising systematic tests and inspections. Thus the tenants are required to inspect all fire pails once a week and to see that they are kept filled and to have a fire drill once a month so that the occupants of the building may become accustomed not only to the signal code, but to the means provided for escape. The engineer also tests the fire-alarm system every morning.

The standpipe and hose system are examined casually once a month; but the sprinkler equipment receives considerable attention, for it is recognized as the only effective means for fire fighting. Memorandums kept on file show the dates and general results of observations of the various systems except the automatic sprinklers. For this latter equipment, an elaborate report blank must be filled in and filed with the insurance authorities, showing results of monthly inspections. The usual charge for inspections and reports for only sprinkler systems is $50 a year, but in this case this amount is credited to the engineer's time.

PLANS OF THE U. S. Reclamation Service for the development of water power in Washington are given in Water Supply Paper 369, published by the U. S. Geological Survey, Washington, D. C.

The essential feature of this development is providing for the use of stored water to supplement the supply when streams are at low stage, involving the construction of 5 large reservoirs, 2 of which have been completed and a third well advanced. These reservoirs will be used exclusively for irrigation, but some smaller ones will be used for power as well as for increase of the water available for irrigation.

At the present time, some 300,000 acres of land are irrigated, and 14,000 hp. is available from present plants along the Yakima river. The estimate is, that the water from this river will irrigate 650,000 acres of land, furnishing 132,000 hp. continuously, and an additional 155,000 hp. for pumping during the irrigation season. On the Naches river, which is a tributary of the Yakima, the power available is 97,900 hp., with an additional 62,000 hp. during the irrigation season, and most of the power sites on this river can deliver energy with relatively short transmission lines.

Power Matters in Congress

WATER POWER DEVELOPMENT; THE NEW TREASURY DEPARTMENT POWER PLANT. BY A. P. CONNOR.

NEVER before has the Congress of the United States had so many and such important power matters before it for consideration; and all of them are receiving their full quota of attack and support. The power bills have been referred to before in Practical Engineer, and their aspect is somewhat the same now as at the time of the previous discussion. The first bill and one which the President advocated in one of his messages to Congress refers to the leasing of water power sites in the public lands. The second refers to permission for damming of navigable rivers, and the third power matter of interest is the erection of a power plant for a number of the departments of the Government in Washington.

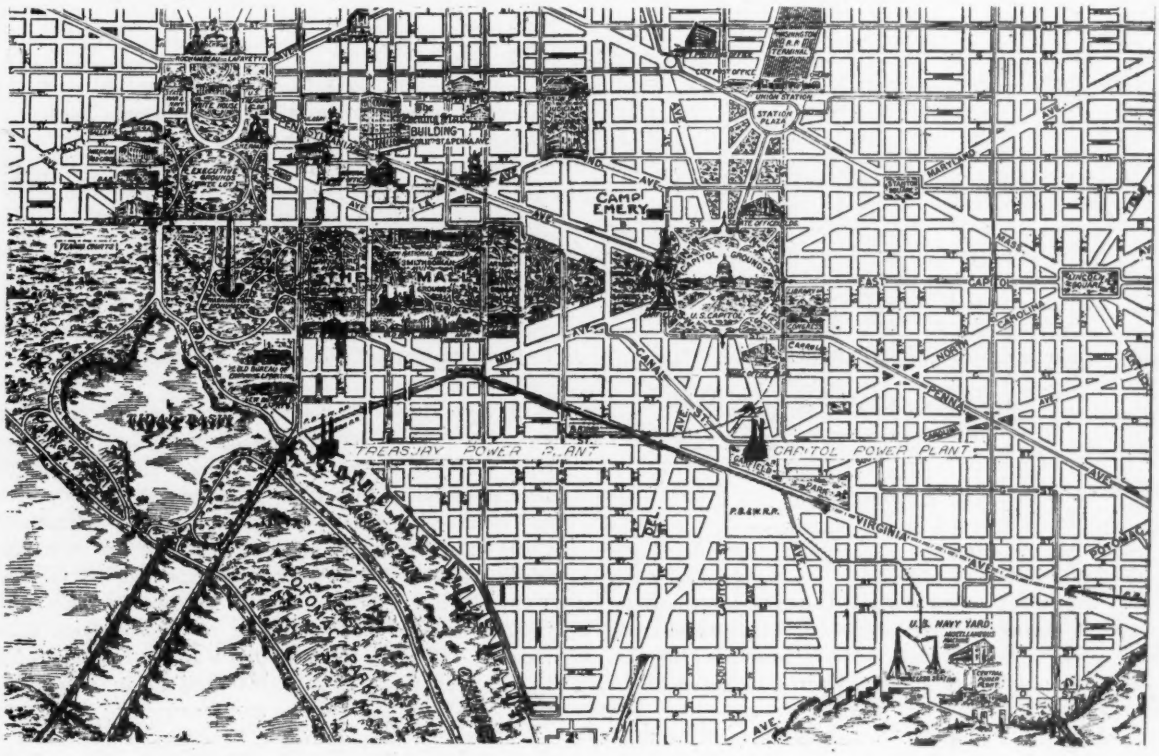


FIG. 1. LOCATIONS OF THE 3 WASHINGTON PLANTS AND BUILDINGS TO BE SUPPLIED

The Public Lands Bill provides for the leasing of power sites in the reserves of the Federal Government, to private parties. It is intended to be for the protection of the "people," but while it appears to have many desirable points, it does not seem to be on lines that would fairly represent the desires of the people at all. One provision is for the leasing of the property for 50 yr. or less, and possible acquirement by the Government after that. This, in general, is a good point in the bill. Another feature permits the Government to investigate the affairs of the leasing company in a paternal way and with possibility of directing its affairs; this is of doubtful desirability. A further feature provides for various ways of taxing the property and at the same time directing the rates chargeable for current. While good in principle, this appears to be defective in practice, because the lessee is not informed definitely beforehand what the taxes will be or how they are to be determined. Other peculiarities of the bill permit municipalities to obtain the sites without restrictions; also taxes obtained from private parties who are lessees will be divided between the state in which the site is located, and to the Government in equal parts. Any reason for this method of dividing profits is hard to find. Money paid the Government goes to a special fund that is usable for a special bureau of the Secretary of the Interior and it would seem that this bureau would be able to disburse the moneys so obtained without further legislation. This is a peculiar defect in the Bill and looks too much like "a family affair" within the department that is sponsor for the bill. There is no provision for the proper consideration of applicants for the leases, nor for experts to pass thereon. In fact the writer is under the impression that the bill is of an elementary nature in this day of development and progress.

It may be news to some readers that at the present time the Secretary of the Interior has power to lease these properties, but the main difficulty is that this power appears to be indefinite.

The navigable rivers bill appears to be receiving less notoriety than the Public Lands Bill, but it is even more important. It refers to damming rivers and their utilization for power purposes without affecting the navigability of the river. In this case, the bill provides a possibility of the private lessee being put to the entire expense of providing navigation facilities which do not already exist and which are demanded on a scale for which the Government will not appropriate at the present time or even consider; and then the lessee has to provide, free of charge, such necessities as power for locks and lighting, and attendance, etc. At the same time the Government remains in full control of the lessees affairs and charges. There seems to be no large amount of consideration in these bills for anybody but the Government, and even then it would appear that the Government is not ready to say what it will take until after the leases are made. This feature does not protect the people, because it permits the leasing of power sites only to parties that are strong enough to prevent official tyranny

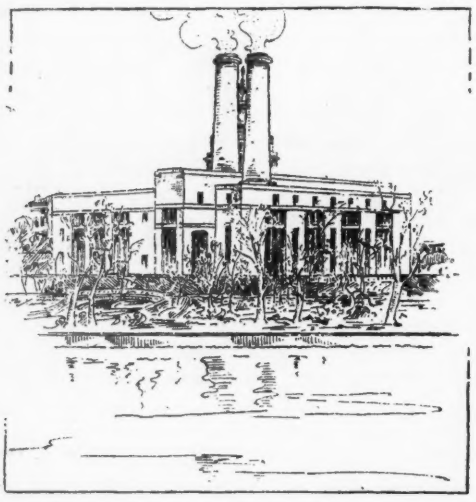


FIG. 2. SKETCH BY GLENN BROWN SHOWING INTERFERENCE OF MALL PLANT STACKS WITH VIEW OF CAPITOL DOME FROM BRIDGE IN POTOMAC PARK

for no others would dare take the risk that is now apparently before them. Readers who have an interest in these bills, should acquire copies of them and acquaint themselves with their contents fully because Congress can now consider suggestions. The time for such suggestion is short and those who desire to submit any information or suggestions should do so immediately, and perhaps preferably through their Congressmen.

The power plant matter in the city of Washington, is one of special interest to everybody. The Treasury Department has let the contract for the erection of a power plant for supplying a number of government buildings with light, heat and power. It located the plant at a place in its own neighborhood and with a possible interference with the artistic appearance of the government buildings and layout. The Treasury Department appears to be the only party that can justify the location and the fact that the contract has been let serves to give it a probable upper hand in the matter. The reasons submitted by the Treasury Department in support of its choice of this location have been objected to by many prominent engineers and have been criticised by members of all the most prominent engineering societies and architectural associations throughout the country. Briefly, the architects and the public trade and citizens organizations object to the stacks of the power house being so conspicuous in the vicinity of the Washington Monument and buildings of a monumental nature that has lately been erected in that vicinity.

Congress has appointed a commission, which has existed for a number of years, to see that monstrosities were not imposed amongst the buildings, but for some unknown reason the Treasury Department saw fit to leave this commission out of the matter until the last minute, and when it became aware of the circumstance, this commission objected strenuously to the erection of the plant at the point selected.

The Treasury Department has endeavored to support its contentions by blaming the local power company for instigating the present opposition to its proposed action, and has testified that the elimination of the stacks and the installation of mechanical draft would involve a cost of tens of thousands of dollars more. The outcome is awaited with interest and several senators have taken an active interest in seeing that an objectionable power plant is not intruded on the landscape of a space designed and laid out for the reception of buildings that will make the national capital of the United States the most beautiful in the world.

In order that the readers of Practical Engineer may know the conditions exactly, diagrams are given herewith, and it is believed that the engineering features have several problems that will be of especial interest. Some $3000 has so far been expended by the contractors at the Treasury Department or "Mall" power plant site, while about $2,300,000 has been expended on the Navy Yard Central Plant. The Government now uses some 200,000 tons of coal annually of which about 39,000 tons of coal goes to buildings which will be supplied by the Mall plant and 170,000 tons to other buildings, now served by the Capitol and Navy Yard plants, and by individual plants. Some buildings, Naval Observatory, Soldiers' Home, Bureau of Standards and Industrial Home School are too far from any capital station site to be supplied economically with steam for heating, but all are within 5 miles of any one of the plants so that no obstacle is offered to transmission of current for light and power, and the consumption of these 4 plants is altogether 12,000 tons a year. None of them is included in the buildings for which supply is proposed from the Mall plant.

Cost of the Mall plant with proposed additions will be $1,634,000, and it would seem that in view of the fact that most of the heavy users of coal, except the Bureau of Engraving and Printing are practically nearer to or as near the capitol and Navy Yard plants as the Mall plant, this sum might better be used in increasing the capacity of those plants already in existence than in building a new plant in a location which seems to be open to serious objections.

Disappearing Ammonia

CAUSES OF FLUCTUATING AMMONIA LEVEL, HIGH TEMPERATURE AND LOW CAPACITY COMPRESSION REFRIGERATING SYSTEMS. BY THOMAS G. THURSTON

ONE machine was working on 2 different systems, a brine cooler for a cold storage plant and 2 ice tanks. Everything went lovely until warm weather came on and the ice tanks were crowded and more refrigeration was needed in the cold storage.

The cold storage brine was held at 15 deg. and the ice tanks were normally held at the same temperature. When the ice tanks were crowded the temperature would sometimes go up to 21 or 22 deg. Every time this happened, the ammonia would run short and there was trouble in holding the cold storage brine down. When the ice tanks came down again, there was all kinds of ammonia. Nobody was able to account for it. One day when the cold storage was in pretty good shape, the engineer shut off the expansion valve on the cooler, when the ammonia began to disappear. To his surprise, the cold storage brine held the same as usual for several hours, and he had all kinds of ammonia.

When the temperature rose in the ice tanks, it raised the back pressure and consequently the boiling point of the ammonia. This reduced the rate of evaporation in the brine cooler and the ammonia accumulated in the cooler until it was almost full. This accounted for the disappearance of the ammonia.

The same trouble was experienced in a small packing house where the whole load was taken care of by one machine.

The coils were all connected for bottom expansion. The beef coolers varied in temperature from 50 deg., when the coolers were just filled, to about 35 deg. when the beef was chilled. A couple of other coolers were held at 36 deg.; the freezers averaged about 18 deg. Whenever the temperature of the beef rooms was high, the ammonia would disappear from the receiver, and as soon as they came down again, there would be plenty.

One day the engineer shut off the freezers when the ammonia began to run short, so as to have enough to run the beef coolers, as they expected to have an extra heavy day.

To his surprise, the freezers held their temperature nearly all day, and he had the receiver nearly full of ammonia in the afternoon. When the temperature in the beef coolers went up, the back pressure rose, and of course the boiling point of the ammonia. With a high back pressure there was practically no temperature difference between the ammonia and the temperature of the cooler. The coils, being fed from the bottom, filled up till they were nearly full of liquid. When the back pressure began to go down, this would lower the boiling point of the ammonia in the freezers, and it would begin to boil out and get back to the receiver. When the engineer shut off the freezers, the coils were pretty well filled, and it kept boiling out slowly all day; this is why they held their temperature all day and why his ammonia kept accumulating in the receiver.

VARIED QUANTITY OF COOLING WATER

IN ANOTHER plant, the ammonia had a habit of disappearing every morning and coming back again in the evening after the night watch came on. This went along for a long time without anyone being able to find the reason. The condensing water, after being used over the condenser, was used in the plant. During the day, a large quantity of water was used and at night, very little. To economize, the day man ran all of the water used, over the condenser to get a low head pressure. At night, the night man had to cut down on the water and raise the head pressure. The machines were also slowed down in the morning and speeded up at night. One day, the day engineer was home, sick, and the machines were run at the same speed and head pressure at they had been all night, the water for the plant being pumped direct from the city mains instead of going over the condenser. They had plenty of ammonia all day. The next day, the regular engineer came back and, after being told what happened, he decided to try it himself, which he did with the same results.

The condenser was extra large for the installation. When more water was turned on and the head pressure came down, the volume of gas was reduced and the proportion of liquid increased on account of the more rapid condensation and a greater amount of liquid was contained in the condenser. In addition to this, the slowing down of the machines reduced the velocity through the condenser, and this increased the tendency for the liquid to "hang up" in the condenser. Of course, if there had been a sufficient charge of ammonia in the system to run it at the low head pressure, there would have been no trouble, although there would have been a superabundance of ammonia at the high head pressure.

CLOGGED WATER PIPE CAUSED BY LEAKING AMMONIA

IN STARTING a large condenser after it had been standing out of service all winter, it failed to keep the head pressure down to where it had been able to keep it the previous season with the same machine working on it. It was of the double-pipe type in 2 sections. One section ran very hot and the other normal; every coil in the hot section was tested to see if the water pipes were blocked, but they were all clear. In damp weather, the section running normal would sweat same as a cold water pipe, but the other remained perfectly dry. That is how attention was first attracted to the difference. One day it was decided to see what the section was doing and a man was stationed to watch the head pressure and the machine, and the water was shut off the normal section, one stand at a time, with the valves at the top and bottom of each stand. The head pressure went right up as the coils were cut off, and the machine had to shut down; evidently the one section was doing nothing at all. There was a feed and return header for each section. The headers were connected to the feed and return water lines by tees at the center of each header. The water was shut off and the caps removed from the ends of the return header on the bad section. A long rod was run through, and when it came to the center of the header, it struck a solid ob-

struction. This was directly opposite the tee that connected the header to the return line. A little pressure was put on the return line and 2 men with rods at each end started jabbing away at the obstruction. Pieces of chalk-like substance began to come out with the water. Several pieces nearly as large as the 6-in. pipe came out until finally the pipe was clear. The tee connecting the header with the return line had been nearly closed up, as could be seen by several of the large chunks that came out, which had only a small hole in the center.

The deposit had been formed by a combination of ammonia and the impurities in the water. Well water was used and it had an excessive amount of impurities in it. A couple of coils near the center of the header just opposite the tee had split pipes, letting the ammonia leak through into the water. We had found considerable of this same substance in pipes in these stands when replacing the defective pipes. A large amount of the sediment and impurities had accumulated at the tee and when the ammonia mixed with it, it formed a soft white substance something like slaked lime and when the condenser was out of service during the winter, it hardened and became a solid mass.

What Opening the By-pass Did

In a plant where the one machine had become altogether too small to take care of the work, another machine had been added of the same size as the old one. It didn't work properly from the start; it ran much hotter than the other machine, and the back pressure ran about 5 lb. lower, but this was attributed to a variation in the gages. It did not have the expected effect on the refrigeration; in fact, there was not a very marked difference in running the old machine alone and the 2 together. It was thought that the suction line was too small, so an additional line was put in. This did not help matters any. Running alone, the machine would not do anywhere near the work the old machine would do. Things went along this way for some time. One day the engineer was making tests for leaks along the suction line to this machine. There was an automatic check valve in the suction line, and it was provided with a by-pass. Curious to know whether it was open or shut, he happened to open it a little while trying it. There was a curious hissing sound in the valve, same as when a steam valve is cracked off the seat. Being of an inquisitive turn of mind, he opened it a little more at a time until it was wide open. The hissing in the valve could be plainly heard from the floor, now, when he got down. Glancing at the back pressure gage, he was surprised to see that it had come up a couple of pounds. The machine was also considerably cooler. Puzzled, the engineer sat down to think it over. Evidently there was a considerable difference in pressure on the 2 sides of the automatic valve or there wouldn't be the hissing through the by-pass; the rise in the back pressure and the reduction in the machine temperature all seemed to point to some restriction in the suction line at the automatic check valve and the engineer was on the point of deciding to take the valve apart when he happened to think of something else.

There was a ½-in. pipe connected between the automatic check valve in the suction line and the discharge side of the machine with a valve in it. This valve had always been closed and the engineer had been told by the men who installed the machine that it should be kept shut. He decided to experiment with this valve and see what the effect would be to run with it open, so he went over and opened it, watching the back pressure gage as he did so; as soon as the valve had been opened about half a turn, there was a click in the automatic valve, the back pressure jumped up several pounds and right after there came a series of thumps and knocks in the machine so that he thought the head would come off and he shut the small valve off again. The whistling in the automatic valve had stopped. When the racket had subsided, he tried the valve again; this time nothing happened. The machine was ice cold and the back pressure was now 5 lb. higher than the other machine. This had been the cause of the trouble. The small line was connected to the discharge side of the machine so that the discharge pressure would keep it open and in case of accident to the machine the release of the pressure would close the automatic check valve in the suction line. Closing the valve in the small line had the same effect. When the engineer opened the valve, it opened the check valve. This raised the back pressure and a quantity of liquid that had been lying in the suction line back of the check valve was swept along with the sudden rush of the gas in the line when the valve opened and this caused the racket in the machine. There was a welcome increase in refrigerating capacity and the new machine would now do more work than the old one.

U. S. Civil Service Commission announces an examination for engineer-economist on April 18 to fill vacancies in this position in the Office of Public Roads and Rural Engineering, Department of Agriculture, Washington, D. C., at salaries ranging from $2000 to $2500, duties to involve questions of organization, questions of the various phases of financing public improvements, the correlation and economic disposition of equipment, the installation and operation of adequate systems of cost keeping and reports, the dissemination of knowledge by means of lectures and papers (referred to as extension work), and in some cases the supervision of road construction and maintenance. Graduation in civil engineering from a technical school or college of recognized standing and at least 4 yr. experience in highway engineering, 2 yr. of which must have been in responsible charge of highway work involving practical application of economic features, such as questions of organizations, the various phases of financing public improvements, the correlation and economic disposition of equipment, the installation and operation of adequate systems of cost keeping and reports, and the dissemination of knowledge by means of lectures and papers; or in the case of those who have not graduated, at least 8 yr. experience in highway engineering work, or a combination of educational training and experience aggregating 8 yr., 2 of which must have been in responsible charge of highway work involving practical application of economic features, such as are described above, are prerequisites for consideration for this position. Persons who desire this examination should apply for Form 1312.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Redesigning Blowoff Piping

WHILE THE MATTER of blowoff piping arrangement does not usually attract any special attention, it is nevertheless a subject which should have careful consideration, from the standpoint not only of safety, but economy as well. The condition as encountered in connection with a plant recently overhauled, will serve to show how many important, yet perfectly obvious, features in a boiler blowoff system can be neglected at a loss in efficiency and economy.

In the plant in question, the blowoff piping as originally installed was as shown in Fig. 1. The changes which were made at the time of overhauling the plant are as enumerated below and shown in Fig. 2.

The first thing noticed was a constant stream of water flowing into the blowoff tank from the blowoff line, which indicated that one or more of the blowoff valves was leaking constantly. A rough approximation

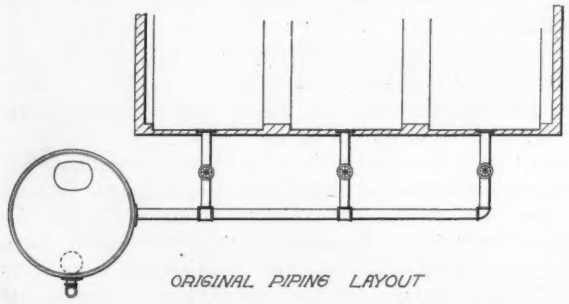


FIG. 1. ORIGINAL BLOWOFF PIPING

showed that this leak alone was costing about 3 tons of coal a month, and since city water had to be purchased, the water loss ran up into several dollars a month.

When a start was made to locate the source of trouble, it was found impossible to spot the faulty valve because the piping was so arranged that there was no way of cutting one or more of the boilers off from the blowoff line, thus giving the opportunity of checking each valve individually. Of course, a good stop valve or cock should have been installed next to the blowoff valve, between the blowoff valve and boiler, so that any unit could be shut off absolutely from the blowoff piping in order to test for leakage. This auxiliary valve is also necessary when it is desired to take the blowoff valve out of the line for examination and repairs while the boiler is in service.

Another point concerned the blowoff piping itself. When it was found that the dismantling of the piping was necessary, it was found to have been made up with screwed fittings instead of flanged fittings, as should have been used to allow taking out any portion of the piping connections for cleaning, repairs, etc., without disturbing the whole system of piping.

It was also found that all turns in the piping, even the connection into the blowoff header itself, were made by means of 90-deg. right-angle fittings. Wherever possible, these 90-deg. fittings were eliminated and 45-deg. elbows or laterals used in order to eliminate as much friction as possible, as well as to minimize pockets for the collection of sediment.

The main blowoff header was also found to be the same size as the individual blowoff connection, although 3 2-in. lines connected into it. The header as revised was 2 in. at the extreme end, increased to 3 in. to take care of the 2 blowoffs, and beyond the third connection increased to 3½ in. to the blowoff tank. While under ordinary conditions but one boiler would be blown down at a time, it was deemed desirable to provide for the free escape of the blow-down water even should 2

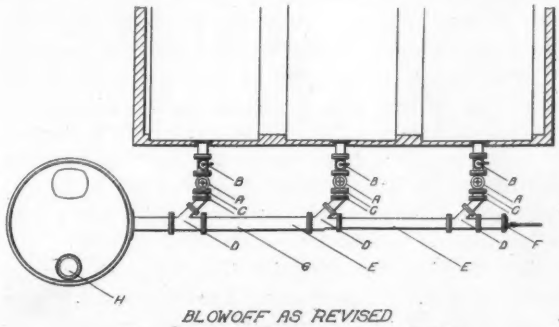


FIG. 2. REVISED BLOWOFF PIPING

of the boilers be blown down at a time. In figuring this piping, it was borne in mind that the velocity of the blowoff water and sludge is high, which tended to increase the frictional resistance, and liberal allowances were made for the heavy sludge and mud usually present in blowoff.

The new blowoff header was also arranged with an air connection at the end farthest away from the blowoff tank by means of which air could be admitted under pressure to blow out the loose sludge and mud which deposited in the header after blowing down. Subsequently, it was found that this air purging was not sufficiently thorough, and hence the blank flange at the end of the header was used as a cleaning door through which a tube cleaner was run with excellent results at regular intervals.

Instead of running the blowoff pipe perfectly level to the blowoff tank, a pitch of about 5 deg. was maintained in the main header so that the soft mud and sludge would have a tendency to flow towards the blowoff tank.

It was also noted at each blowing down that violent disturbances took place in the blowoff tank. It was found that the atmospheric vent was made up of 2-in. pipe, the size of the original blowoff piping, which was unable to carry off the large amount of steam discharged by the blow-down. This vent was increased in size to 4 in., and was taken from the top of the tank instead of the side to eliminate one bend. A gate valve which was placed in the 2-in. vent line was also eliminated in order to prevent any restriction in the vent line, or unwitting closing of the vent line altogether.

M. SALLER.

Some Peculiarities of Upright Blowing Engines

WE HAVE laid down in some of our books that compression should be carried to a point as near boiler pressure as possible. I was always a great believer in compression as a money saver, and as an aid to smooth running; but I came across one type of engine in which it was impractical to have any compression or, in fact, any lead. To secure smooth running, the diagram should show no compression and a negative lead on the bottom end.

The engines in question were upright blowing engines used to blow Bessemer converters. They were 36 by 48 in. with Corliss hand-regulated releasing valve gear. The blowing cylinders were in line with the steam cylinders and the 2 pistons were directly connected. The air was admitted and discharged from the air cylinder by valves similar to pump valves and normally closed by light spring pressure. There was considerable clearance in the air cylinder, as much as 10 per cent, and the pressure on the blast pipe was 28-lb. gage. The pressure in the air cylinder would continue to rise until it reached the pressure in the blast main—28 lb.; this occurred when the piston had reached approximately ¾ of the stroke, and this pressure continued until the piston reached the end and started on the return stroke.

Now, the idea of compression from a smooth running standpoint is for the purpose of overcoming the inertia or power stored in the rapidly moving reciprocating parts of the engine; but with a tandem compressor, there is already a force acting to stop these reciprocating parts so there is then no necessity for compression on that score. From the economy standpoint the idea is all right, but practically it won't work; because the pressure in the steam cylinder is rapidly diminishing at the time when the pressure in the air cylinder is at its highest, and the difference between the power consumed and the power generated must be made up by the flywheels. To have a compression pressure built up at the end of the stroke would stop the engine on the center and for the same reason there can be no lead.

There is another peculiarity of this type of engine. It is a well-known fact that the guides of ordinary engines are worn most in the center; but with an upright tandem compressor the wear is mostly at the ends, or rather near the ends. The steam pressure being high during the early part of the stroke, with a low air pressure, the surplus energy is stored in the flywheels. This pushing on the connecting rods puts considerable strain or pressure on the guides. At about ½ stroke, the energy consumed equals the energy generated and the flywheels are just floating, neither absorbing nor giving off power; but a little farther in the stroke, the energy generated is growing less while the energy required is increasing and this difference must be made up by the flywheels, thus causing extra pressure on the guides at about ¾ of the stroke due to the push of the connecting rods by the flywheels driving the load. With the next half of the cycle the same things take place, only the pressure on the guide is in the opposite direction and consequently on the other guide. The net result is practically no wear on the center or the ends of the guides; but between the center and the ends, there is a zone of wear on both sides of the center of both guides and of about the same amount.

S. P. BAIRD.

Taking Up Wear on Bearings

IN THE ISSUE of March 1, a subscriber asks the question, "At what part of the stroke should the crank be placed when taking up for wear of wrist and crankpin boxes?"

The part of the answer relating to the crankpin is correct, but in reference to the wristpin the answer states ". . . But for taking up on the wristpin it is best to have the engine set with the crank at 90 deg., since there is a tendency for the wristpin to wear oval, and if adjustments are made with the crank horizontal, adjustment is likely to take up too much so that the box may bind on the wristpin when it comes to the 90 deg. point."

In theory, the above statement is substantially correct; but in practice it cannot, in the majority of cases be done in this manner. Nearly every engine in use today has bored guides or the frame of the engine is such that it is closed above and below the guides (this refers to a horizontal engine), and open at one or both sides. And also in the majority of engines in use the wedge construction is such that the wedge moves vertically across the connecting rod in adjusting, and nearly all have an adjustment bolt threaded and screwed into the wedge to hold it in place with a lock nut on the bottom to prevent its turning or sometimes 2 bolts are used, one screwed into the wedge from the top and the other from the bottom to hold the wedge in its proper place. With the crank placed at 90 deg., either the head or nut of this adjusting bolt is thrown back under the shoe and it is absolutely impossible to get a wrench on it. In fact, the only point of the stroke at which it can be reached, and turned, is the back center, which brings the crosshead back near the cylinder with the rod in line with the center line of the cylinder. This applies to the marine type of rod end as well as to the wedge and draw bolt type. An exception to this rule might be found in the rod having the wedge draw in from the side.

In regard to getting the box too light with the rod in this position, it is necessary to give the box some clearance even if it is taken up on the part of the pin having the greatest diameter; it is no more difficult to make the adjustment on the small diameter when the proper clearance is allowed to compensate for the unequal diameter of the pin if the same method of keying

up is pursued each time, and as a matter of practice this clearance must be allowed for the reason that in the majority of cases the smaller diameter is the only point at which the wedge is accessible. If the pin is worn very much, it should be turned through an arc of 90 deg. to cause it to wear on the larger diameter and prevent any chance of binding.

In taking up on the quarter boxes, I find the best method is to have the engine running with the usual load, then loosen the wedge bolts, of whatever type they may be, until the bearing pounds perceptibly, then tighten them up equally just enough to stop the pound but no more. This stops the pound or knock, which is the aim in view, and eliminates any possibility of getting the bearing too tight which might be the case in tightened up with the engine standing idle, and it also reduces the friction to a minimum. If possible, all bearings should be taken up while the temperature of the working parts is near the running temperature, as the expansion and contraction in some cases is considerable and if taken up when cold may be too tight after warming up. J. C. HAWKINS.

Refacing Valve Seats

SOME MAKES of steam pumps, equipped with the type of water-end valves and discs shown in the accompanying illustration have their seats cut or pitted by grit and as a consequence, are a source of much annoyance due to leakage. This, in the majority of plants, means the removal of the valve plates and taking them to a machine shop for refacing.

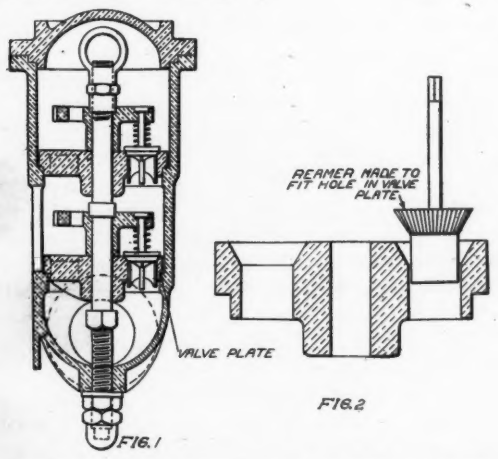


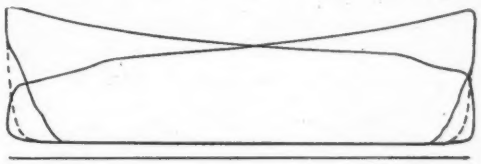
FIG. 1. VALVE SEATS WHICH MAY READILY BE PLACED IN PROPER ORDER BY USE OF A REAMER
FIG. 2. REAMER AND METHOD OF USING

The same results are obtainable with much less trouble by the employment of a reamer used with a hand wrench or in connection with a portable electric drill. The entire set of suction and discharge valve plates can be reseated in a very few minutes.

As the valves are generally placed in a circle, a standard valve reseating machine cannot well be used; the reamer is much better, as it requires no adjustments and may be made the size and angle of teeth required. C. H. WILLEY.

Criticism of Ice Machine Card

IN MARCH 1 ISSUE, page 260, J. A. McInnis asks readers to criticise his indicator diagram No. 3, taken from the steam cylinder of an ice machine. It seems to me that he has about the right adjustment of both valve and eccentric for proper steam distribution with that kind of valve gear. Whether or not the compression is excessive is an open question. Personally, I favor as little compression as possible, consistent, of course, with quiet running, and so the valve closes before the end of the stroke, to prevent blowing through of live steam into the exhaust part. If Mr. McInnis is in favor of less compression than that shown on his card No. 3, I think he can easily settle the question—as far as that engine is concerned, at least—by setting the eccentric back about ½ as much more as he moved it ahead, as shown in



SUGGESTED CHANGE IN COMPRESSION SHOWN BY DOTTED LINES

card No. 2 to card No. 3. That would still permit an early enough release, and would reduce the compression to the least amount desirable to prevent a blow-through. With that size and speed engine, not much compression is required.

This is particularly true, when there is compression going on at the other end, in the ammonia cylinder. Possibly, by placing the piston valve in the lathe and taking off a small amount of metal at both outside ends (being an indirect valve which exhausts at the ends instead of at the center), he may accomplish his desires, without changing the live steam events, which are good at present. Probably 1/16 in. taken off at both exhaust ends of the valve will do the trick. Judging from the diagrams I don't think any mistake would be made by doing this. CHARLES J. MASON.

Using Graphite in Boilers

A SHORT TIME AGO I read an article in the Practical Engineer by M. L. on the peculiar experience he had with graphite being carried over with steam.

I can say that I have used graphite in my boilers for nearly 3 years and have not had any trouble as yet.

In connection with generating power, steam is used to scald and steam fancy fruit and vegetables in steam boxes and exhausters in direct contact with the fruit, and we would soon hear about it if any graphite was found there.

Our boilers are operated above rating at all times and my belief is that the engineer of whom M. L. writes must have used too much graphite.

I find after the graphite has been used a short time it is well to cut down the amount fed, and only once in every two or three days then. Such is my experience. C. M. B.

Exit the Jack Shaft

WHEN I WENT to learn belt practice I was taught that the correct way to "step down" from a high-speed motor to a low-speed shaft, where the size of the motor pulley is small and the size of the shaft pulley is large, was to proceed as shown in Fig. 1. It was a fad in the old days to use plenty of pulleys, all for the sake of keeping the arc of belt contact as large as possible on all pulleys. Therefore, that this method is still in vogue is not surprising; but it should nevertheless be abandoned in favor of the scheme shown in Fig. 2, which is decidedly more modern.

An idler pulley is not a great consumer of power, as is so much preached. An idler drive is not bad design. And belt tensions need not be high where idlers are used.

Most laymen seem to think that an idler should be used to tighten the belt, but not so. The idler should be used merely to increase arc of pulling contact, and the belt can continue to run fairly loose.

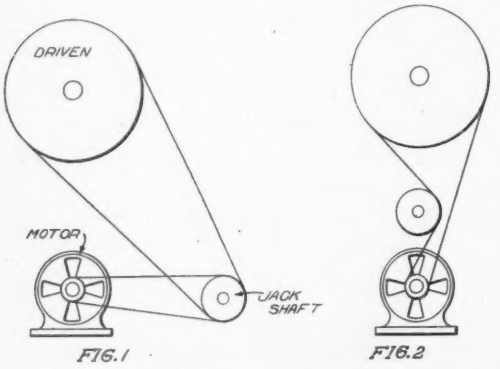


FIG. 1. OLD METHOD OF REDUCING SPEED
FIG. 2. BEST METHOD OF INCREASING ARC OF CONTACT

It has been proved in actual test that idlers consume so little power, where properly designed, that the power loss is negligible. The idler should be well lined, and its diameter should be about 1½ times the diameter of the smallest pulley in the drive. It should always be placed on the slack side of the belt and never on the tight side.

Comparing Figs. 1 and 2, for instance, it is evident that the following points are true:

There is bound to be more belt slip in Fig. 1. The enormous pull on the jack shaft of Fig. 1 causes a much greater friction loss in the bearings than would be possible in an idler of even miserable design. Figure 2 is certainly more compact and looks better than Fig. 1, which is an important item in many plants. The first cost of Fig. 1 is greatest. In Fig. 2 there is less danger of tie-up due to belt breakage or breakage of lacing, for there is only one belt. Output from Fig. 2 will be greatest, on account of less belt slip. On account of the greater simplicity and fewer belts, there is less danger of accident.

As far as I can see, therefore, Fig. 1, the old method, has little if anything to recommend it. Let's do away with it. N. G. NEAR.

Installing a Gasket

MR. PALMER'S article in Feb. 1 issue, page 183, was interesting, but I consider my way better. My way of making a gasket is to caliper inside the bolt holes, to get the outside diameter of the gasket, and make a circle of this diameter on the packing. Inside this circle I draw another circle representing the pipe diameter, and cut on these lines, this gives me a gasket to fit inside of bolts, which gives a greater binding power to the flange bolts. Some may see objections in putting this gasket in place, but by putting in 3 or more bolts to support the gasket on a horizontal line, it becomes an easy matter.

I had an experience in replacing a gasket between my steam chest and steam pipe flange on a Rollins engine. The old gasket started to blow out about 8:00 a. m. one day, and I held it in by wire until noon, but did not dare to let it go through the afternoon run; so I put a new gasket in at noon. Coming up from the steam chest there were stud bolts, and the flange could not be raised high enough to clear the top of the bolts unless a brick wall was broken away.

I laid thin strips across the hole, crowded the gasket in between 2 bolts, and held it in place with a packing hook while the strips were removed. This is another instance when a gasket inside the bolt holes is the one to use. This job was finished in 40 min.

In some of the flange joints there is not enough bearing surface, and in this case you must come outside the holes. W. N. L.

Feed Heating in the Boiler Breeching

LACK OF any method of heating feed water is responsible for a surprising amount of excess coal consumption in many plants, particularly throughout the Northwest. An arrangement to overcome this can be made at reasonable cost to suit many plants, and the results will probably surprise those operating the plants. This is available where the breeching from the boiler to the stack is of ample size and carries away gases at high heat. Sufficient good quality pipe should be secured, with bends and fittings, using approximately 75 ft. of piping within the breeching, and omitting the bends outside the breeching. The pipe should be run from this coil by the shortest route to the boiler, and this run should be covered with good pipe covering so as to save all heat units obtained from the hot gases. The water is sent through this heating coil after leaving the boiler feed pump or injector, and if temperature is measured before and after leaving the breeching, the rise will be found astonishing. A small tight door should be provided in the breeching to permit cleaning soot and ashes from the coil, and the different pipes should be spaced far enough apart so as to permit of getting at them readily to clean all surfaces. The results in saving of coal will be found to pay a liberal return on the investment in a short time. M. G. HENRY.

SENOR NESTOR MAYA, of Caracas, Venezuela, has been authorized to construct a private telephone line 12.4 mi. long from that city to rural property. Contract has been let for electric lighting plants for Rio Caribe and Trujillo in the same country.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Effect of Increasing Quantity of Cooling Water

IF A 175-ton refrigerating plant, equipped with 28 double-pipe condensers, 12 pipes high, 17 ft. long, and using 12 gal. of water per minute per stand, operates at 220 lb. condenser pressure with water at 90 deg. F., what would the condenser pressure be if the amount of cooling water be increased from 12 to 18 gal. per stand?

SUBSCRIBER.

A. Practice has shown that with the usual amount of condenser surface per ton, the pressures resulting from the use of 1, 2 and 3 gal. of 90 deg. F. water per minute per ton, will be respectively about 300, 237 and 218 lb.

If the plant in question is using 12 gal. on 28 condensers, or 336 gal. of 90 deg. F. water for 175 tons, or about 2 gal. per minute per ton, and the condenser pressure is only about 220 lb. instead of 237, it is because of the larger condenser surface of 32.6 lineal feet per ton as against about half that amount supplied under usual conditions.

With a low velocity due to passing only 12 gal. per min. through a single condenser, there is probably not over 12 deg. F. difference in temperature between the water and the ammonia; as a matter of fact the temperature of ammonia at 220 lb. is 102 deg. F. With an increase of 50 per cent in cooling water the difference in temperature will probably be in approximately inverse proportion; in other words, 3 is to 2 as 12 is to 8. That is, the ammonia temperature will probably be about 98 deg. F., corresponding to a pressure of about 208 lb. In submitting this approximation, attention must be called to the fact that it is impossible to figure condenser temperatures and pressures accurately.

If it can be used, a centrifugal pump would be the best means of furnishing the power required to drive the additional cooling water through the condenser.

F. E. MATTHEWS.

Synchronous Motor Installation

WE INTEND to install a synchronous motor in a local flour mill, the current for the operation of this motor to be taken from a 33,000-v. transmission line, the regular load on which is of a non-inductive nature. In fact the power factor of this line is almost always leading.

Will it be possible to regulate and control the power factor by means of this synchronous motor?

2. Would it not also be necessary to install a power factor indicator? W. H. M.

ANSWERS

WITH A lagging power factor, due to an inductive load, over-exciting the field of the synchronous motor will have a tendency to make the power factor approach unity. In a like manner, should the load be of such a nature to cause a leading power factor, under-exciting the motor's field will, in turn, correct this fault.

2. It is, of course, necessary to install a power-factor indicator in order at all times to know the true value of the power factor. O. H. H.

A Transmission Problem

WE ARE INSTALLING 2 50-hp. motors, both to run a single line of shafting. In order to obtain the proper speed, and not use a counter shaft, we would have to use a 10½-ft. pulley on the shaft and a 12-in. pulley on the motor. The motors will be quite heavily loaded.

Do you think the arc of contact of the smaller pulley would be sufficient to carry the load?

2. What distance between centers should we employ if we use the direct drive? D. S. P.

ANSWERS

WE DOUBT if you would find the operation of a heavily loaded, 50-hp. motor satisfactory when belted from a 12-in. pulley to one 126 in. in diameter. The arc of contact on the smaller pulley would be too short to give satisfactory results on the heavy load, particularly if the load varied rapidly so that the motor must pick up load quickly.

There would be 2 possible remedies for this: One, the use of some belt treatment to give extra flexibility to the belt; the other, the use of some form of idler short connected close to the motor, such as the Lenix drive.

There would be a certain advantage in the use of counter shafts between motors and the main shaft, if both motors are to drive the main shaft in parallel. You will realize that unless these motors were regulated to run at exactly the same speed, which might be somewhat difficult, there would be a tendency, particularly when the load varied, for one motor to take more load than the other. If they were heavily loaded, this might result in a considerable overload on one motor, and, in any case, would result in considerable belt slip. The counter shafts would give an extra length of belt and an extra speed reduction, which would tend to take up the inequality of speed during fluctuations.

If the motors are exact duplicates and driven from the same feeders, this variation in speed may not amount to much. It could only be told by trying the motors separately under load, to see how the speed varies with the load.

2. If you use the direct drive, it is advisable to have the distance between center of the motor shaft and the line shaft as great as possible. The longer this distance

the better will the contact be on the small pulley, which is the weak point in the whole transmission; but if you use a Lenix system drive, the centers can be shortened up a good deal without materially reducing the arc of contact on the small pulley.

In case you decide to use the short drive, it will be advisable to use a belt plenty wide so as to reduce the tension per inch of belt width. For such a drive, a wide, thin belt will work better than a narrow, thick one.

A. L. R.

Steam Turbine Questions Asked by Massachusetts Examiners *

WHAT DOES the lower half of the step bearing support?

A. The entire revolving part of the machine.

66. What is this step supporting screw for?

A. It holds the wheels at proper height in the casing and adjusts the clearance between the moving and stationary buckets.

67. What is this plate that acts as a nut for the step screw called?

A. This is a cover plate bolted onto the base of machine; the screw bushing is of bronze.

68. What prevents the lower step from turning?

A. Dowel pins from the cover plate.

69. What are step blocks made of?

A. Cast iron.

70. What is hole up through the screw for?

A. Oil to step.

71. How does the step lubricant work?

A. It is forced up through the hole in the screw and worked in between the steps supporting the rotating disk on a film of oil or water.

72. How is the upper step block fastened to the shaft?

A. It has 2 dowel-pins, also a key that fits into a slot across the bottom of the shaft. The step is counterbored to fit the end of the shaft. The counterbore centering the block; the key compels the block to turn with the shaft.

73. What is the threaded hole in the under side of the top block for?

A. So that a screw may be put in there to pull the top block off the end of the shaft.

74. Why is this necessary?

A. Because the dowel-pins, key and counterbore are close fit.

75. What is a jacking ring?

A. It is found on the shaft and is a loose collar that covers the holes into which 4 plugs are screwed.

76. What type of turbines have this ring?

A. One with a sub-base which is used with oil lubricated step bearings.

77. How may a step bearing be lowered in order to examine it?

A. Some way must be provided to hold the shaft up while its regular support is taken away. With the jacking ring, the plugs are taken out and sets are screwed or bolts are screwed up; this brings the ring against a shoulder on the shaft and holds it there while the step is lowered. On other types, one man goes into the exhaust base while others screw on the big screw until he can put a shim shaped like a horseshoe between the shoulder on the shaft and guide bearing casing, then the screw is backed down while the shim holds the shaft up. Now take off the cover plate, the nuts on long screws holding it in place. The pipe running up through the step bearing screw is taken out. The cover plate is lowered about 2 in., then a rod is screwed into the top step. Block the cover plate so it cannot rise, and with nut on lower end of rod pull the top step down so all can be examined.

78. How do you tell how your clearance is?

A. The clearance between stages varies with the stages from 0.06 to 2 in., and is measured by taper slips that are put in through holes in the casing; these holes are plugged.

79. If not correct, how do you adjust it?

A. By turning the step screw until blades just touch all around, turn the other way the same, now move step screw halfway and clearance is equal.

80. What are "pawls" used for?

A. The pawls are located on a shaft driven by the governor and work a crosshead that opens and shuts the valves.

81. If the valve stem is too long, what may happen?

A. As the pawls come down they will break something; this may be caused by the crosshead unscrewing.

82. What will happen if the crosshead screws on?

A. The pawls will not engage the valves and they will not be opened.

83. How do the stage valves work?

A. They are supposed to operate after the last valve, and let steam into the second nozzles.

84. How do you set the valves on a Curtis?

A. We will consider 2 sets of valves, one set of 5 on each side of the machine. Throw out all pawls, holding them out by putting the springs over the ends. Turn the machine by hand until the pawls for one set of valves are at the highest point; then with valves wide open, adjust drive rods (these rods extend from crank to rock shaft) so that there is 1/32 in. clearance at point of opening of the pawls when they are in. Then set up check nuts on drive rods, and turn the machine slowly over until the pawls are at their lowest point of travel; then with valves closed, adjust each valve stem to give 1/32 in. clearance at the point of closing of the pawls when they are in; lock the check nuts to each valve as it is set. Set valves on the other side of the machine the same. Now with turbine running and synchronizing springs in mid-position, adjust governor rods so that the turbine will run at normal speed when working on fifth valve and full load. The governor rods controlling fifth and sixth valve must be set so that speed will not vary more than 3 to 4 r.p.m.

W. N. L.

*Continued from page 189, Feb. 1 issue.

U. S. CIVIL SERVICE COMMISSION invites attention to the examination for laboratory assistant to be held on April 12-13, to fill vacancies as they may occur in the Bureau of Standards, Department of Commerce, at entrance salaries ranging from $900 to $1200. Apply for a copy of the Manual Examinations for the Spring of 1916 and Form 1312, stating the title, Laboratory Assistant (Male), to the U. S. Civil Service Commission, Washington, D. C.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Stopping Compound Engine

WHAT IS the best method of stopping down a cross-compound Corliss valve engine with condenser attached, so as to avoid having it stop with the high-pressure side on dead center? C. N.

Fusible Plug Trouble

I HAVE NOTICED Mr. O.'s remarks concerning trouble with his fusible safety plugs.

It seems to me that the trouble is due to galvanic action, or electrolysis, which has frequently been advanced as the cause of corrosion in steam boilers. One of the most common precautions against this action is to place slabs or blocks of zinc in the boiler; the zinc being more susceptible to the peculiar galvanic action, is hence attacked and eaten away, instead of the iron boiler shell. The filler of the fusible plug being composed of a large proportion of zinc no doubt acts in the capacity of bearing the brunt of the galvanic action prevalent in Mr. O.'s boiler and hence is quickly eaten away.

This galvanic action has been found to be checked when the water in the boiler is kept alkaline, and therefore Mr. O. might find relief by treating his feed supply with soda ash or caustic soda.

The presence of air in the feed water might also be another cause of the trouble, and the feed water should therefore be heated and the gases driven off before being fed to the boiler. For this purpose, an open heater should prove valuable. M. SALLER.

Construction of Polarity Indicator

IN ANSWER to how to make a polarity indicator, the following may be found of use. If it is desired to ascertain the direction of current flow in a wire, an ordinary steel sewing needle may be magnetized by contact with the poles of a permanent magnet, and suspended by an untwisted fiber of silk, so there will be no unwinding of the suspension to cause the needle to rotate. The north seeking end of the needle may be noted when it is suspended freely in the earth's field, away from all iron or steel objects. If such a suspended magnetized needle be held *above* a horizontal wire carrying a direct current, and in front of the observer, and the north seeking end deflects to the observer's right, the current is passing away from the observer. Any ordinary pivoted compass needle will act as a current indicator as above. Such a compass needle may be "calibrated" by passing a wire under it, that is connected with an ordinary dry-cell. The zinc of the dry-cell having the negative terminal.

An ordinary potato acts as a polarity indicator. If the 2 copper terminals from a 110-volt or 220-volt circuit are inserted into a potato, the substance of the potato turns dark green around the positive terminal. Care should be taken not to allow the 2 ends of the wires to come into contact with each other. F. E. AUSTIN.

REFERRING TO "Construction of Polarity Indicator," page 269, March 1, polarity indicators up to 600 v. are so cheap that it does not pay to take the trouble necessary in making them. A polarity indicator for battery, 0-50 v. or one for 50-600 v. can be bought for $0.85 net. This instrument will indicate the negative and positive poles when connected across the line, or in series with a circuit. If he desires to indicate polarity for over 600 v. I will give the necessary data if he will write direct to me giving voltage of circuit. The size of the indicator mentioned above is 1 in. diameter by 3½ in. long.

H. E. WEIGHTMAN.

Cleaning Injector

IN CONNECTION with the matter of keeping injector throats clean I have heard of the case of a contracting concern using injectors on an erection job where exceptionally bad water was used for boiler feeding, and as a result the injector throats gave considerable trouble because of clogging due to scale formation.

They first tried to chip out the scale, but this was found to be most unsatisfactory. Then they tried to boil the throats in a strong solution of caustic soda and soda ash. This brought the scale down quickly, but it had the effect of seriously corroding the throats, the brass injector parts being attacked by the caustic solution.

To remedy this, the throats were made up specially of iron, which could be boiled in the alkali solution without bad effects.

A spare set of iron throats, one in service while the other was out of service, and being boiled out with the alkali solution, proved to be the only satisfactory solution to the problem. M. SALLER.

Cleaning Gage Glasses

IN FEB. 1 issue, M. Y. recommends a swab made of fine wire for cleaning gage glasses. This is an entirely wrong practice and not to be recommended, as a glass tube of a water gage that comes in contact with any metal may fly to pieces in a very short time, or while in process of cleaning or installing. Some makes of glasses will not stand for passing a wire (either steel wire or copper), through, for some unexplained reason, even without touching the sides of the glass. Every engineer should be acquainted with this fact and so be protected from possible injury. CHAS. BEHOUNEK.

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Beyond the Ash-Pit

In the average power plant it is not commonly recognized that an economy leak may exist beyond the ash-pit. The plant manager or chief engineer deems his time wisely used in considering peak loads, feed water temperatures, and various other things peculiar to power plants. Ash and refuse to him are merely something to be disposed of, the sooner the better, but with little regard to the hows or whys of an economical and efficient method of disposal.

Very seldom, also, does he give any consideration to the amount of combustible in the ash. A statement from time to time, of the percentage of combustible, and the operating conditions under which it was obtained, would be of vital importance in deciding on the most efficient method of operation.

The method of ash-handling which was in vogue when he assumed charge of the plant is sweetly accepted along with the other methods and policies of his predecessor. If the power capacity is increased, a haphazard attempt is made to run the ash handling system a little harder each day in order to keep the pits clean.

In the event of a steady increase in the plant capacity, a careful investigation should be made from time to time to determine whether or not the old system is adequate, and from a standpoint of economy and efficiency, whether the installation of a new system would be justified.

To discover the most efficient system of handling and disposing of the ash and refuse does not necessarily require expensive experiments. It does require some orderly observations and notes; some computing of the costs of maintenance, power and labor, covering a fair duration of time, and under average operating conditions. A summary of the results will enable one to prove conclusively whether or not the present system can be improved upon. A closer analysis will point out defects and disclose opportunity for improvement.

A plant operating in northern Illinois equipped with 10,000 boiler hp., and disposing of 60 tons of ashes and refuse daily, made a change in its system. At the end of a year the result was a saving of $4230, and during this time there was a slight increase of power output over the preceding year. Another plant, operating on a smaller scale, made a saving of $2850 by making a change in its system at the suggestion of a fireman.

Whenever it is suggested that improvements can be made in a certain plant, the old bugaboo is sometimes used that "this plant is different." In very few cases it is true that the plant location, ash-pit design, and other conditions may be unfavorable and restrict the plant to one particular method of ash handling. Such cases are rare exceptions and the chances are that the particular method employed can be successfully "trimmed up" and some dead branches chopped off.

This is an era of preparedness. The plant manager should prepare to hammer down his operating expenses wherever possible. As he reduces his expenses and promotes efficiency, his rating and value to his employer increase in direct proportion.

Investigate your method of handling ashes and refuse. Try to find some faults, to eliminate them, and to suggest some genuine improvements.

News Notes

THE PLANS of the Vocational Education Association of the Middle West, which will hold its Second Annual Convention at the Hotel La Salle, Chicago, March 30 to April 1, includes a series of papers on the Gary System, to be presented on Thursday afternoon, March 30, at 2 o'clock, a banquet in the Ballroom of the Hotel La Salle, Thursday evening, with addresses by members of the Chicago schools, conference of committees and visits to schools on Friday morning, a series of papers on Work for Women on Friday afternoon, Problems in Agricultural Education on Friday evening, Schools and Training for Employment on Saturday morning, and a description of some experiments in education on Saturday afternoon. A commercial exhibit will be held on the 18th floor, showing school equipment and demonstrations.

OFFICES HAVE BEEN OPENED in Washington by the Water Power Development Association, a national organization composed of manufacturers of water wheels, hydraulic and electrical machinery, equipment and supplies, whose business has been injured by stagnation in hydro-electric construction work in the last few years.

The purpose is to carry on a campaign of publicity intended to aid the Administration in securing passage of laws to encourage the development of water powers in the public domain and on navigable streams, such laws being required at present by the general dam act and the leasing bill for power sites in the public domain, which are supported by the President and Cabinet Officers.

The Association is not as yet committed to any particular bill or any particular plan of legislation, but desires only such legislation as will bring development and use of the water powers now going to waste, and will also fully protect the interests of the public and of investors in these enterprises.

TWENTY-FIRST ANNUAL CONVENTION of the New York State Association N. A. S. E., will be held in Yonkers, N. Y., and in connection with this, there will be an exhibit of steam apparatus and accessories, the cost of a booth with a display, card (5 ft. long) and 2 badges being $15.

Further information can be had from Wm. Roberts, secretary of the committee, Tuckahoe Road, Yonkers, N. Y.

THE D. T. WILLIAMS VALVE CO., of Cincinnati, announces the election of A. G. Muhlhauser as secretary of the company.

NELSON VALVE CO. has secured the services of E. A. Hamilton as Assistant Manager of Sales. Mr. Hamilton was formerly manager of the Philadelphia branch of the C. A. Dunham Co., Marshalltown, Iowa, manufacturers of Vapor Heating Systems. He will have special charge of advertising, sales promotion, and assures to all Nelson customers prompt and satisfactory service.

FARNSWORTH MANUFACTURING CO., with plant and office headquarters at 65 Beverly St., Boston, Mass., has succeeded F. C. Farnsworth Co., of 72 Trinity Place, New York City, and will continue the manufacture of the several types of Farnsworth traps, boiler feeders and other specialties, with modern plant and equipment.

The new organization has as officers, F. C. Farnsworth, president; Howard W. Evans, vice-president and general manager, and Kenneth L. Lindsey, treasurer. Mr. Farnsworth, who is the inventor of the Farnsworth specialties, has withdrawn from engineering and contracting at the Bush Terminal, Brooklyn, and will give his entire time to the development of these specialties, retaining the former office at 72 Trinity Place, New York City. Mr. Evans is widely known as a power piping engineer, and has had long experience in some of the leading power piping houses in the country. He will have management of the business, with headquarters in Boston. Mr. Lindsey, who acts as treasurer, is a prominent business man of Boston and graduate of Harvard University. The entire effort of the officers and their experience will be devoted to giving the best service to those requiring condensation utilities.

DR. F. W. CUNNINGHAM of Orange, N. J., has resigned his connection with the research and development work of the Newark plant of the General Electric Co. to join the Engineering Research Staff of the Powdered Coal Engineering & Equipment Co., of Chicago, at which point he has been located since March 1. In his new connection, Dr. Cunningham will considerably broaden the field of his activities.

DARWIN ALMY, inventor of the water tube boiler which bears his name, and president and treasurer of a corporation which manufacture the device, died at his home in Providence, R. I., on Mar. 9, aged 68.

As an inventor and member of engineering societies he was widely known.

Mr. Almy was born in Tiverton, a son of Isaac C. and Alice (Bateman) Almy. In 1874 he went to Providence, and went into the jewelry manufacturing business with Edwin A. Baker, but only remained thus engaged for 2 yr. In 1879 he became associated with the Herreshoff Manufacturing Co. at Bristol as foreman of the boiler and engineering departments. For 11 yr. he was in charge of all of the trial trips made by the defenders in international contests.

U. S. CIVIL SERVICE COMMISSION announces an examination for mechanical and electrical inspector on April 19 to fill a vacancy in the position of foreman of power plant at the Naval Proving Grounds, Indian Head, Maryland, at $6.72 a day. The duties of the position will consist in inspecting and supervising the installation being erected under contract for the Navy Department and conducting acceptancy tests in order to insure safety and durability and to oversee the operation of those portions of the power equipment already in operation at the Naval Proving Grounds. After completion the appointee will be placed in charge of the plant if his services prove satisfactory. Applicants must have had at least 5 yr. experience in mechanical and electrical engineering along similar lines to those required as outlined above. A bachelor's degree in engineering from a college or university of recognized standing will be considered as equivalent to 2½ yr. of such experience. Apply for Form 1312, stating the title of the examination for which the form is desired, to the U. S. Civil Service Commission.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

New Type of Vacuum Pump

A NEW dry vacuum pump, the "Ingersoll-Rogler," has recently been developed from the Ingersoll-Rand Co.'s line of straight line air compressors, and placed on the market for condenser service and other duties requiring the maintenance of a high vacuum.

These machines are of the horizontal, center-crank type and are built both steam and power driven. A feature, pointed out by the maker to be a marked improvement, is the substitution of an automatic lubrication system for the usual grease cups found on machines of this kind. Removable cast covers prevent the lubricant from escaping, and, while affording quick access to all parts completely exclude dust and grit.

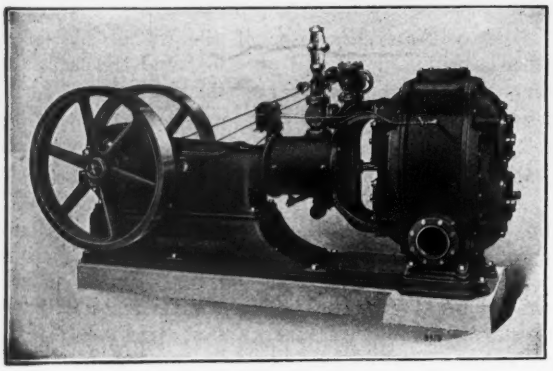

FIG. 1. INGERSOLL-ROGLER STEAM DRIVEN STRAIGHT LINE VACUUM PUMP

Vacuum cylinders are fitted with "Ingersoll-Rogler" valves, a type which has proven highly satisfactory in air compressor service. They are automatic in action, are of the multi-ported plate type and are featured by ample port opening with slight lift. It is also to be noted that these valves need no lubrication. Inlet valves are placed in the top and discharge valves in the bottom of the cylinder heads, which construction provides for the immediate discharge of any liquid entering the cylinder. Water jacketing on both cylinder barrels and heads is said to increase the efficiency by keeping down the heat generated in the vacuum cylinders.

The power driven machine is often furnished with short-belted electric motor as a complete unit, as well as with plain belt wheel for other drive. The steam driven type has a balanced piston steam valve which permits its operation on high pressure and superheated steam. Both vacuum and steam cylinders are lubricated by a force feed lubrication. These steam driven machines are furnished with a continuous sub-base under the entire unit.

Due to the high operative speeds, permissible with low lift plate valves of the 'Ingersoll-Rogler" type, it has been possible for the manufacturer so to increase the capacity of a pump of a given size that in comparison with equal capacity machines of the old type the floor space occupied is reduced to a marked degree. This saving is said by the Ingersoll-Rand Company to be about ⅔.

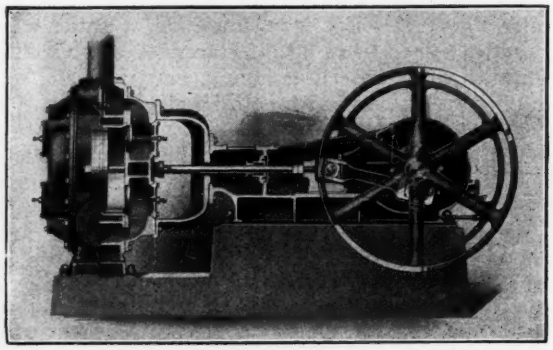

FIG. 2. SECTIONAL VIEW OF POWER DRIVEN INGERSOLL-ROGLER VACUUM PUMP

"Ingersoll-Rogler" vacuum pumps range in capacity from 292 to 2295 cu. ft. per min., and are guaranteed by the manufacturer to maintain a vacuum of within ½ in. of barometer against a closed intake. They are also capable of handling discharge pressures of several pounds.

CALORIZED METAL soot blower units, as used in the Diamond mechanical soot blower system for water-tube boilers, that have been installed in the hottest parts of boilers, and subjected continuously to combustion gases at extreme temperatures for a period of more than a year, show no signs of disintegration. The Diamond Power Specialty Co. has been granted the exclusive right to the use of the calorizing process for mechanical soot blower units by the General Electric Co., patentees, but concerns engaged in other lines of business have made some interesting tests with this metal.

The Westinghouse Lamp Co. uses calorized metal tubes in furnaces where the temperature is in the neighborhood of 900 to 1000 deg. C. At this temperature the life is normally double that of wrought iron tubes. The Denver Rock Drill Mfg. Co. uses calorized pipe in temperatures of 1650 to 1700 deg. F., and reports that these tubes last 10 times as long as plain pipe.

Calorized pipe is used in pyrometers as protecting tubes. Reports from users of the Bristol pyrometer indicate that the calorized pipes last from 3 to 5 times as long as wrought iron or steel pipes.

Pocket CO_2 Indicator

AMONG the reasons flue gas analyses are not made as a part of the daily routine of every boiler room is the apparent complication of making an analysis and inconvenience of carrying the instrument from place to place about the plant. Power plant men will therefore welcome the introduction upon the market of the Pocket CO_2 Indicator, manufactured by the Bacharach Industrial Instrument Co. of Pittsburgh, which is small in size, easily operated and sufficiently accurate for power plant purposes.

With this instrument the time required to make one determination is about 2½ min., thus giving a means that is rapid enough for a study of furnace conditions. To operate the instrument, the lower bulb is filled with a solution of caustic potash (one filling being sufficient

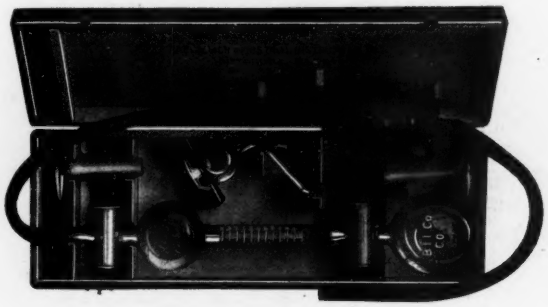

FIG. 1. BACHARACH POCKET CO_2 INDICATOR

for 200 determinations); a sample of the gas is then pumped through the upper cock into the graduated neck of the instrument. When this has become completely filled with the gas to be tested the upper cock is closed and the lower cock turned 180 deg. which permits the gas and caustic potash to come into direct contact. The caustic potash absorbs the CO_2 contained in the gas forming a partial vacuum in the instrument. After sufficient time for this chemical action to take place the lower cock is closed, the instrument inverted and immersed in water. The upper cock (that is, the one through which the gas entered the instrument) is opened and water enters to take the place of the CO_2 absorbed. After closing the cock again and bringing the apparatus to the normal upright position, the per cent of CO_2 is read off on the tube at the water level.

Catalog Notes

CATALOG NO. 75 has just been received from Murray Iron Works Co., and describes the new "Duplex" internally-fired boilers manufactured by this company. It is well illustrated with half tones from photographs showing clearly the construction and characteristic features of the large and small sizes.

AN INTERESTING FOLDER entitled "The Rubber Plant" is sent out by the Quaker City Rubber Co., emphasizing the value of Quaker City products and giving interesting facts in regard to rubber manufacture and uses.

THE GOODRICH is the title of a magazine published by the B. F. Goodrich Co., of Akron, O., with a primary purpose, of course, of emphasizing the value of Goodrich products and also to put its salesmen and customers in touch with its activities.

The March number is a most interesting publication, and brings out many novel ideas in regard to the construction of tires, of rubber footwear, waterproof clothing, rubber belting, hose, insulated wire and other products. There is as much of interest in it to the mechanical man as in most of the popular monthly magazines.

TRAP DATA valuable to everybody connected with the power plant are given in a recent catalog, entitled New Bundy Steam Traps, issued by the Nashua Machine Co., Nashua, N. H. Not only are the Bundy traps

described in detail, but direction for installing these traps for various uses are given and much learned from this catalog in regard to handling condensate economically.

SOME-INSTALLATIONS of Westinghouse Switchboards is the title of a 20-page folder just issued by the Westinghouse Electric & Mfg. Co. This folder illustrates the switchboards, control desks and switching equipments in some of the largest and most important of recent power developments and gives an excellent idea of some of the work being done by the Westinghouse Co. in the switchboard line.

ROSS "CROSSHEAD-GUIDED" expansion joint, made by the Ross Heater & Mfg. Co., of Buffalo, N. Y., is described in attractive, instructive catalog, which shows the construction of the joint, the method of determining when such joints should be used, and the way they should be installed.

HOMESTEAD VALVE MFG. CO., Pittsburgh, Pa., has just published a new catalog containing interesting facts and data. The catalog may be secured by writing to the company, P. O. Box 1754, and mentioning Practical Engineer.

THE JONES STOKER is the title embossed on the cover of an attractive catalog just issued by the Underfeed Stoker Co. of America. This shows in complete detail the construction of the Jones underfeed stoker, and the method of application to various types of boilers, as well as the control system for mechanical draft where this is used. It is a fine piece of catalog work, and will be found of great interest, particularly to those having smoke abatement problems to solve.

Trade Notes

OHIO BLOWER CO. has recently added to its line, the Swartwout Hydromatic products, which include steam traps, water level controlling valves and low-pressure boiler feeders. These were formerly manufactured by the Engineers Appliance Co., of Cleveland, O., but will in future be manufactured and sold by the Ohio Blower Co. and its representatives.

FOLLOWING ARE some of the recent orders for gas engines recently booked by The Bruce-Macbeth Engine Co., Cleveland, O.: Commercial Auto Body & Mfg. Co., Cleveland, 1 90-hp. natural gas engine for factory drive; Atlantic Foundry Co., Akron, O., 1 125-hp. natural gas engine (repeat order); American Window Glass Co., Belle Vernon, Pa., 1 150-hp. natural gas engine; Universal Rolling Mill Co., Bridgeville, Pa., 1 150-hp. natural gas engine (third order); American Well and Prospecting Co., Corsicana, Texas, 1 150-hp. natural gas engine; George W. Wood, Birmingham, Mich., 1 35-hp. twin cylinder producer gas engine for driving refrigerating machinery; Turner & Moore Mfg. Co., Detroit, Mich., 1 150-hp., 4-cylinder artificial gas engine; Wheats Ice Cream Co., Akron, N. Y., 1 60-hp., twin-cylinder natural gas engine (eighth engine ordered); Budd Dairy Co., Columbus, O., 1 150-hp., 4-cylinder natural gas engine; Bickett Machine & Mfg. Co., Cincinnati, O., 1 90-hp., 4-cylinder natural gas engine; Cross Gear & Engine Co., Detroit, Mich., 1 60-hp. artificial gas engine.

ON FRIDAY, March 2 and 3, a salesman's conference of unusual significance was held at the plant of the B. F. Goodrich Co., Akron, O., under the direction of W. O. Rutherford, general sales manager. This took the form of a good-fellowship homecoming, attended by 450 Goodrich salesmen from all sections of the country, except the Pacific Coast.

The program centered around the idea of bringing the men into closer personal relationship, and giving them by inspection of the factories, an opportunity to get close first-hand information on the romance of rubber manufacture, and the details of the tires, boots and shoes, belting, hose, mechanical goods and sundries made in these great factories. Part of the inspection was of the 3 new buildings erected during the last 6 months, which have added 700,000 sq. ft. to the Goodrich plant.

After the banquet, addresses, all of which sounded the note of promised future prosperity for the company, were made by W. O. Rutherford, general sales manager; E. C. Shaw, second vice-president; C. B. Raymond, secretary; E. C. Tibbitts, advertising manager; J. C. Lawrence, credit manager, and Dr. W. C. Geer, head of the Development Department, who told the story of how crude rubber is compounded to make it adapted for the hundreds of commercial uses to which it is put.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH.

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All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 22,500.

Technical Publishing Co.

537 S. Dearborn Street

Chicago

Position Wanted

POSITION WANTED—As master mechanic or assistant; 21 years' experience. Had charge of erecting, repairing heavy duty engines, machinery and mixed blow turbines. Expert on lubricants. Address Practical Engineer, Box 435, Chicago, Ill. 4-1-1

WANTED—Position as engineer in pumping station or in some stationary plant. I have had 4 years' experience in engineering. What have you to offer? E. W. Adkins, Charleston, Ill. 4-1-1

POSITION WANTED—By engineer and electrician who is a technical graduate and has had 13 years practical experience. At present employed but prefer change. 5 years in present position. Reduced fuel consumption from 33 tons to 24 tons per day. Have own indicator. Can handle the Orsat. Married. Age 32. I can guarantee results. Address Perry Bartram, Box 264, Cedar Point, Ill. 4-1-1

POSITION WANTED—By chief engineer, 35; married. Use no liquor; 15 years' experience, electrical and refrigeration. Wants position where ability and push will count. Can get results if given opportunity. Practical Engineer, Box 436, Chicago, Ill. 3-15-2

POSITION WANTED—License chief engineer wants change; 12 years' experience in manufacturing and central stations, steam, electrical, refrigeration and producer gas, high speed and Corliss engines, condensers, etc. Age 32, American, and married. Address Box 437, Practical Engineer, Chicago, Ill. 4-1-1

POSITION WANTED—Chief engineer in a small plant or operator in a large; 12 years' practical experience with steam, electric, refrigerating, pumping and condensing equipment. Technical education. First-class license and references; married, age 31, employed. Practical Engineer, Box 434, Chicago, Ill. 3-15-2

POSITION WANTED—As assistant engineer or oiler. Have had experience in steam, electric and village pumping plants. Other particulars answered by mail. J. G. Wilson, R. D. 2, Bangor, Mich. 3-15-2

POSITION WANTED—Inside of power plant by young man with a technical education, but no experience. For particulars write to K. Lufter, Kewaunee, Wis. 3-15-2

Help Wanted

ILLINOIS STATE CIVIL SERVICE COMMISSION—Chief Electrician—Examination will be held at several Illinois cities on April 1, 1916, for Chief Electrician. Salary $100 to $130 a month. Open to men over 25 years old residing in Illinois. Good physical condition required. One position in State Capitol at Springfield now open. Applications must be filed before March 25. For application blanks and further details write State Civil Service Commission at Springfield, Ill., or Room 904, 130 N. Fifth Ave., Chicago. 4-1-1

FREE ENGINEER BOOKS and power plant tools and specialties for securing new subscribers to Practical Engineer. A dandy chance for the engineer with a little spare time, to get some fine premiums. Send for free descriptive circular and terms. Address Practical Engineer, Subscription Department, Chicago, Ill.

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis Mo.; San Francisco, Cal.; Washington, D. C. This is an excellent chance for a hustler, who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago. tf.

Wanted

THE MERIAM COMPANY, Power Plant Engineers, are in the market for second-hand generators and alternators, 25 to 200 kw. Address the Meriam Company, 235 Superior Ave., N. W., Cleveland, Ohio. 4-1-1

WANTED—Well versed boiler room and combustion men or established engineering agencies to sell mechanical stokers on a liberal commission basis. We manufacture three distinct types to meet all requirements. Natural and forced draft. Address, Practical Engineer, Box 438, Chicago, Ill. 4-1-4

WANTED—Agents handling engine and boiler-room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Address Practical Engineer, Box 381, Chicago, Ill. tf.

WANTED—Agents on commission to sell our Shaking Grates. We will install grates on trial or put it on test at our expense with any grate made. Address Armstrong Mfg. Company, Springfield, Ohio. tf.

For Sale

FOR SALE—Second-hand generating units: Two 75-kw. Ridgway direct connected generators and engines, 230 volt. Practically new, $800 each. Engines: 18 by 36 Allis-Chalmers Corliss engine, latest type, heavy duty frame. Practically new. $800. Boilers: Two 250-hp. Babcock-Wilcox watertube, 150 lb. pressure, 4 yr. service. Good as new. $2000 for both. Seven 150-hp. return tubular, butt strapped, 125 lb. pressure. Fine condition. $450 each. Power Plant Exchange, 14 Morris St., Jersey City, N. J. 4-1-1

FOR SALE—Drawings of Internal Combustion Engines: (1) Section Four-Cycle Diesel Engine, (2) Section Two-Cycle Diesel Engine, (3) Section Two-Cycle Crude Petroleum Engine, (4) Section Two-Cycle Crude Oil Engine. (5) Air Starting and Reversing System for Diesel Engines. (6) Tre-Ignition Starting and Reversing System for Oil Engines. For one dollar each, or five dollars for the six, I will send the above to any address in the U. S. With each drawing I enclose full explanation of operation. H. J. Teiper, 180 S. Logan Square, Philadelphia, Pa.

FOR SALE—Six volumes of Practical Engineer, six volumes of National Engineer, several copies of Power and Southern Engineer. Will sell as a whole, single volumes or numbers. Address Box 341, Sidney, Mont. 4-1-2

Patents and Patent Attorneys

PATENTS THAT PROTECT AND PAY—Advice and books free. Highest references. Best results. Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F St., N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact costs. Send for full information. tf.

A. P. CONNOR, Consulting Electrical and Mechanical Engineer. Attorney-at-Law and Solicitor of Patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D .C tf.-x.

PATENTS—Send sketch for free search and reports. Books on patents and book of reference letters sent free. John S. Duffie & Co., 612 F St., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Technical Books

ENGINEERS AND FIREMEN—Send 10c in stamps for a 40-page pamphlet containing a list of question asked by an examining board of engineers. Stromberg Publishing Co., 2238-A Pope Ave., St. Louis, Mo. E.O.I.-tf.

Miscellaneous

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill.

Sparks From The Advertising Pages

"Modern Advertising," said Mr. A. R. Maujer, in a recent address before the Ohio Society of Mechanical, Electrical and Steam Engineers, "is increasing the rapidity with which progress in engineering is being made. It is constantly raising the general level of efficiency in all branches of engineering. It does these two things by eliminating time. Information which once took months and years to spread thinly can now be spread thickly almost overnight. So the modern advertised invention or new product, instead of struggling weakly to an anemic or belated maturity, or dying an untimely and obscure death, springs rapidly to a widespread usefulness and paves the way for still further improvement."

Let us add to this idea the fact that the man who advertises simply must maintain the standard of his product.

He **must** watch for opportunities to improve his goods in order that he may truthfully claim as much or more than his competitors do.

He **must** protect you in every way he can from disappointment in your purchases from him.

He **must** strive continually to make your dealings with him not only safe, but easy and agreeable.

These things he must do or the money he spends for advertising is entirely wasted. Does he know it? Indeed he does.

If you doubt it, go through the advertising pages of this issue of Practical Engineer and note the common sense, informative, reason-why selling "talks" you'll find. You'll see they're prepared on the assumption that you know your business and that only good, logical reasons will be accepted by you in substantiation of the claims that are made.

Practical Engineer readers have found out that Practical Engineer advertisers are to be depended upon.

Practical Engineer advertisers have found out that Practical Engineer readers are men of intelligence—men who are responsible—men who have power to buy, or influence amounting to the same thing.

Read the ads and write for literature describing the things that interest you. And buy advertised goods—for your own protection.